

PHASE II WORKPLAN
Omega Chemical Site PRP Organized Group
Whittier, California
Project No. 399-A

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**OMEGA CHEMICAL SITE
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Project Coordinator**

Via Facsimile

Original to Follow via Federal Express

(415) 744-1916

October 27, 1995

Ms. Kathryn D. Lawrence
Federal On-Scene Coordinator
U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, CA 94105

Re: Omega Chemical Corporation Site;
U.S. EPA CERCLA Section 106 Order No. 95-15
Phase II Workplan

Dear Ms. Lawrence:

On behalf of the Omega Chemical Site PRP Organized Group (Group), enclosed is the Group's final Phase II Workplan for approval by U.S. Environmental Protection Agency (EPA). As you know, the Group has prepared the Phase II Workplan for additional investigative and response activities at the Omega Chemical Corporation Site (Site) in Whittier, California pursuant to EPA's May 9, 1995 CERCLA Section 106(a) Unilateral Administrative Order (Order).

The Group has diligently worked with EPA and its representatives to revise the Phase II Workplan in accordance with EPA's comments by the October 27, 1995 deadline. Attached to this facsimile letter is the text of the Phase II Workplan and list of Group members in good standing which have committed to perform the work described in the Phase II Workplan. We are sending the complete Phase II Workplan including attachments, as well as copies of the Group members' individual Notices of Intent to implement the Phase II Workplan, via Federal Express. As you will note, the list of Group members committed to implementing the Phase II Workplan includes most of the Second Wave PRPs, who will also be joining the Group.

The enclosed final Phase II Workplan incorporates virtually all of EPA's requested comments which we discussed during our October 24 conference call/meeting. Since June of this year, the Group has expended approximately \$3.4 million to remove hazardous waste drums and containers from the Site, and is committed to performing the additional Site sampling and stabilization activities described in the Phase II Workplan consistent with the terms of EPA's Order.



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COORDINATION, CLIENT REPRESENTATION AND ENVIRONMENTAL MANAGEMENT

Kathryn D. Lawrence
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Thank you for your assistance and cooperation in this matter. We look forward to EPA's approval of the Phase II Workplan. If you have any questions concerning this letter, please contact me.

Sincerely,

A handwritten signature in dark ink, appearing to read "Ian A. Webster" followed by a stylized flourish or initials.

Ian Webster, Project Coordinator
For the Omega Chemical Site
PRP Organized Group

cc: David Rabbino, Assistant Regional Counsel
John P. Jaros, Enforcement Officer

Omega Organized Group Members

PHASE II WORKPLAN
Omega Chemical Site
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Whittier, California
Project No. 399-A

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ACRONYMS & ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
APR	air purifying respirators
BCA	BC Analytical, Inc., Anaheim, California
bgs	below ground surface
BTEX	benzene, toluene, ethyl benzene and xylenes
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CCR	California Code of Regulations
CLP	contract laboratory program
CPT	cone penetrometer test
DQO	data quality objective
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EC	electrical conductivity
England/Hargis	England & Associates / Hargis + Associates, Inc.
EPA	U.S. Environmental Protection Agency
ERT	Environmental Research & Technology
FID	flame ionization detector
HASP	Health and Safety Plan
HVOC	halogenated volatile organic compound
IDW	investigation derived waste
LACDPW	Los Angeles County Department of Public Works
LCS	laboratory control standard
LSA	laboratory services agreement
mg/kg	milligrams per kilogram
MSD	matrix spike duplicate
MUL	maximum use limit
NIOSH	National Institute for Occupational Safety and Health
NRC	National Response Center
Omega	Omega Chemical Corporation and Omega Refrigerant Reclamation, collectively
OPOG	Omega Chemical Site PRP Organized Group
Order	Administrative Order No. 95-15, as amended
OSHA	Occupational Safety and Health Administration
OVA	organic vapor analyzer
PARCC	precision, accuracy, representativeness, completeness, and comparability
PEL	permissible exposure limit
PF	protection factors
PPE	personal protective equipment
ppm	parts per million

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PRP	potentially responsible party
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
REL	recommended exposure level
RDL	reporting detection limit
RPD	relative percent difference
RQ	reportable quantity
RWQCB	California Regional Water Quality Control Board, Los Angeles Region
the site	Omega Chemical site, Whittier, California
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOC	semi-volatile organic compound
TCLP	Toxicity Characteristic Leaching Procedure
TLV	threshold limit value
TM	Technical Memorandum
ug/kg	micrograms per kilogram
ug/l	micrograms per liter
Unilateral Order	May 9, 1995, Unilateral Administrative Order, Docket Number 95-15
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
Watermaster	Southern District Watermaster

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1.0 INTRODUCTION

This Phase II Workplan (Plan) has been prepared for the Omega Chemical Site PRP Organized Group (OPOG) by the team of England & Associates and Hargis + Associates, Inc. (England/Hargis). This Plan has been prepared in response to Administrative Order No. 95-15 as amended (Order) issued pursuant to Section 106 of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, 42 USC Section 9606. The Order was issued by the U.S. Environmental Protection Agency (EPA), effective June 1, 1995, and amended effective September 12, 1995. EPA has by a letter dated September 19, 1995, extended various deadlines in the Order.

1.1 Objective

England/Hargis has prepared this Plan to satisfy the Phase II activities required by Paragraph 21(h-i) of the Order.

- "h. Conduct surface and subsurface soil sampling and groundwater sampling to determine the nature and extent of contamination.*
- i. Dispose, stabilize or treat grossly contaminated concrete, asphalt and/or soils found at or near the surface at the direction of the OSC."*

With Phase I drum removal complete, no grossly contaminated concrete, asphalt, or near surface soils are evident. Therefore it appears that item (i) has been completed. If grossly contaminated concrete, asphalt, or near-surface soils are discovered during the investigation, item (i) work will be assessed by a Technical Memorandum to the EPA at that time. This Plan satisfies item (h). It is not the purpose of the assessment to serve as a Remedial Investigation nor to gain site closure.

To meet these objectives, the Plan contains the following elements:

- Approach
- Scope of Work
- Quality Assurance

The Health & Safety Plan, Standard Operating Procedures for Field Activities, and Quality Assurance Procedures are included as Appendices.

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1.2 Site Description

The Site is located in Los Angeles County, California, at 12504 and 12512 East Whittier Boulevard, in the City of Whittier (Figures 1 and 2). The Site is approximately 40,000 square feet in area and contains two structures: a 150x160 foot warehouse and an 80x30 foot administrative building (Figure 3). These buildings are surrounded by a concrete-paved service yard. A 7-foot high chain link fence topped with razor wire has been installed along the property boundaries, fully enclosing the property.

Solvent and refrigerant reclaiming operations took place inside and outside of the south end of the warehouse building. Distillation columns, evaporators and related equipment were used in this area. Tankage was generally outside in areas shown on Figure 3.

Drums and tanks containing hazardous materials were removed from the site during Phase I. Tanks and equipment left on-site have been decontaminated.

1.3 Site History

Information contained in this paragraph is from Administrative Record Document 38 (*Interim Measures Removal Action Workplan, Omega Chemical Corporation...*, Draft, IT Corporation, March 3, 1995). Prior to 1963, a business named Sierra Bullets operated the facility. Sierra Bullets reportedly stored kerosene in an underground storage tank, which was removed in 1987. The total duration of Sierra Bullets' occupancy is not currently known. The property was subsequently purchased by Fred R. Rippy in 1963. A business that converted vans to ambulances operated at the site from 1966 to 1971. In 1976, Omega purchased Bachelor Chemical Processing, which was located on the northwestern half of the property, and assumed the lease from Mr. Rippy. In 1987, Omega purchased the parcel and the additional southeastern section from Mr. Rippy to comprise the present site.

According to the Administrative Order, Omega Chemical Corporation and Omega Refrigerant Reclamation (collectively, Omega), operated at the site from 1976 until at least 1991. The site is currently owned by Mr. Dennis O'Meara, president of Omega.

The Omega site operated as a spent solvent recycling and treatment facility handling primarily chlorinated hydrocarbons and chlorofluorocarbons. Drums and bulk loads of waste solvents and chemicals from various industrial activities were processed to produce commercial products. Chemical, thermal and physical treatment processes were used to recycle and reuse the wastes. Wastes generated from these treatment activities included still bottoms, aqueous fractions and non-recoverable solvents (EPA, 1995).

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According to the Order, prior to 1989, much of the service yard may have been unpaved or partially paved with asphalt. The present concrete pad was installed in 1989. Its integrity remains good based on an inspection at the conclusion of the Phase I drum removal action.

1.4 Previous Investigations

Based on information from the Administrative Record for the Omega site, several subsurface investigations have been conducted. These are listed by report title, consultant and report date, and Administrative Record Number as follows:

1. *Investigation of Subsurface Soil Contamination at Tank Farm, Omega Chemical Corporation*, Leroy Crandall and Associates, June 26, 1985, (AR 3).
2. *Results of Laboratory Analysis Performed on Soil Samples Collected After the Removal of an Underground Tank...*, Leighton and Associates, August 26, 1987, (AR 4).
3. *Report on Soil Vapor Survey...*, Environmental Research & Technology (ERT), February 2, 1988, (AR 6).
4. *Report on Site Assessment Investigations at Omega Recovery Facility...*, ENSR Consulting & Engineering, October 1988, (AR 7).

Approximate sampling locations and total VOC results for these four investigations are shown on Figure 4.

The 1985 investigation included five hand auger borings with soil samples collected at depths ranging from 1 to 8.5 feet below ground surface (bgs) in the tank farm area at the southwest corner of the site. These samples contained VOC concentrations ranging from 10 ppm to over 1,000 ppm in shallow soil (down to 3.5 feet), with little or no VOCs detected in deeper samples.

The 1987 investigation was conducted in connection with removal of a 500-gallon underground storage tank (UST) which was reported by IT Corporation to have been used by Sierra Bullets to store kerosene (AR 38). As shown on Figure 4, the tank was located in the southwest quadrant of the site between the above-mentioned tank farm and the southernmost extension of the building. Leroy Crandall and Associates reported a strong solvent odor during the excavation of the tank. Samples were collected from 2 feet and 4 feet below the bottom of the excavation (10 and 12 feet bgs). These were analyzed for hydrocarbons and halogenated VOCs, and showed concentrations of up to 300 ppm hydrocarbons, over 8 ppm halogenated VOCs and nearly 14 ppm acetone.

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The 1988 soil gas survey by ERT was a qualitative survey in which total vapor concentrations were reported as "minor," "moderate," "substantial" and "very substantial" for 18 of 22 sample points. Four of the samples were not analyzed. There was no identification of individual VOC compounds, nor did the report contain any information regarding sampling procedures or depth of sampling. The figure depicting sampling locations did not show locations of 13 of the samples, although all samples appear to have been taken in the western half of the site. Samples 15 and 16 (Figure 4) were reported as "very substantial," sample 14 was "substantial" and samples 13 and 21 were "moderate." Five other samples, whose locations are not shown, were reported as "substantial."

The 1988 investigation by ENSR included five soil borings with total depths ranging from 20.5 ft bgs to 100 ft bgs. A groundwater monitor well (BMW-1) was installed in the deepest of these borings (Boring BMW-2 did not reach groundwater and was not completed as a well). Concentrations of halogenated VOCs in soil ranged from about 0.04 ppm to over 5 ppm. Groundwater samples were analyzed by EPA Method 8240, with total VOCs measuring nearly 12,000 ppb in one sample. Of that total, Freon 113 accounted for 44 percent. Two subsequent water samples tested by EPA Method 624 showed similar results, except that Freon 113 was not an analyte in those tests. (The ENSR report incorrectly shows non-detected for Freon 113. The laboratory report indicates that compound was not included in the list of Method 624 analytes.)

1.5 Team Organization

Figure 5 presents the project organization chart for the Phase II activities. The Project Coordinator for the Omega Chemical Site PRP Organized Group is Dr. Ian Webster. Dr. Dennis England is the Project Manager for the England/Hargis team and provides project liaison with Dr. Webster and the EPA. Mr. Michael Rendina is the alternative contact at England & Associates in the event Dr. England is temporarily unavailable.

Mr. Michael Palmer of Hargis + Associates, Inc. is the Site Assessment Task Manager. He reports to Dr. England and is supported by Mr. Rendina. The task manager is responsible for overseeing all field activities, for communicating field activities with the project manager, and for coordinating all sampling efforts. The task manager is also responsible for informing field personnel, prior to field work, of the QC practices to be employed; for performing and overseeing QA/QC functions during the course of the project; and for communicating QA/QC status and requirements to the Project Manager.

Dennis England also serves as Engineering Task Manager. Engineering tasks include interpretation and evaluation of data. Evaluation of grossly contaminated surface material, if any is found, will also be the responsibility of the Task Manager.

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Other technical staff from both England and Hargis will provide technical support as needed. Major subcontractors to be used include:

- Soil gas survey HydroGeoChem, Inc.
Huntington Beach, California
- CPT/HydroPunch™ Gregg Drilling
Fountain Valley, California
- Primary analytical laboratory BC Analytical
Anaheim, California

1.6 Weekly Progress Reports

Once this workplan has been approved, weekly written summary reports will be provided to the EPA. These will include a summary of the current and future week's activities. The summary will contain information regarding changes in personnel, the percentage of the project that has been completed, potential problem areas, and the projected work for the following week. Refer to Exhibit A located at the end of this section for a sample report.

1.7 Technical Memoranda

To assist in documenting and detailing a course of action for selected site activities as well as unforeseen changes that may occur in the field, a Technical Memorandum (TM) will be written. The Technical Memorandum will be prepared to ensure a clear line of communication and will be submitted to the EPA for approval. The memorandum will include a brief description of the proposed addition or modification, the purpose of the proposed activity, and possible alternatives. Refer to Exhibit B located at the end of this section for a sample memorandum form.

At this time, Technical Memoranda are expected to be submitted upon completion of the following tasks: (1) location and evaluation of existing well BMW-1; (2) soil gas survey; (3) shallow soil sampling; and removal and disposal options regarding Investigation Derived Waste (IDW). The TM process may be used to assess the management of any grossly contaminated soil, asphalt, or concrete encountered.

1.8 Phase II Report

A final report detailing all Phase II activities will be prepared and provided to the EPA within 30 days of completion of Phase II field activities.

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1.9 Project Schedule

The Project Schedule is presented in summary in Figure 6. A detailed schedule is included in Appendix A. Based on EPA approval of the workplan by October 30, 1995, completion of the field work is expected by the beginning of February 1996 and submittal of the final report by early March 1996. Monthly meetings and/or telephone conference calls are anticipated with EPA to review project status and direction. As discussed in Sections 2.0 and 3.0, selection of sampling locations and sample analyses will depend on the results of the preceding field activities. Therefore, these activities are conducted in serial fashion, rather than simultaneously.

The schedule shows field activities complete in less than 90 days, though laboratory results for the final activities may extend the total time to slightly beyond 90 days. All attempts will be made to keep the field schedule as close to 90 days as possible, however, scheduling conflicts with subcontractors for the field activities could result in modifications of the schedule, as may inclement weather, access difficulties, equipment malfunctions, and injuries/illness affecting key personnel. The soil gas survey subcontractor has been tentatively scheduled for early November to minimize delays. This schedule assumes the EPA will provide timely and lawful access to the Omega site.

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Exhibit A

WEEKLY PROGRESS REPORT NO. ____ Omega Chemical Site

- A. Summary of Work Performed
- B. Percentage of Project Completed
- C. Potential Problem Areas
- D. Actions to be Taken
- E. Projected Work for Next Reporting Period
- F. Summary of Community Interest Groups and Agency Contacts
- G. Changes in Personnel
- H. Inspection Reports

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Exhibit B

TECHNICAL MEMORANDUM No. _____

SUBJECT:
SUBMITTED BY:
SUBMITTED TO:
cc:

DATE:
TASK NO.

-
- 1.0 Purpose
 - 2.0 Need for Proposed Activities
 - 3.0 Evaluation of Alternative Actions
 - 4.0 Description of Required Addition or Modification
 - 5.0 Implementation Schedule
 - 6.0 Health and Safety Issues
 - 7.0 Standard Operating Procedure Issues
 - 8.0 Quality Assurance Program Issues
-

EPA Approval by: _____ Date: _____

- ☐ Approved
- ☐ Disapproved

- ☐ Approved Conditional Upon Attached Comments
- ☐ Additional Information Required

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2.0 APPROACH

As discussed in Section 1.0, this plan will allow OPOG to determine the nature and extent of subsurface contamination. To accomplish the stated objectives, soil and groundwater sampling efforts will focus on the two aspects of the site possessing the most immediate potential for exposure of sensitive receptors to hazardous substances -- shallow surficial materials (including soil) and groundwater.

The nature and extent of contamination will be examined through a scope of work consisting of the following five activities:

1. Existing Data Review and Analysis
2. Shallow Soil Gas Survey
3. Shallow Soil Sampling
4. Location and Evaluation of Existing Well BMW-1
5. Deep Soil Sampling and Groundwater Sampling with Cone Penetrometer

These activities are designed to meet the requirements of paragraph 21(h) of the Order. They will:

- establish whether subsurface contamination exists,
- determine the nature and extent of the contamination,
- define chemicals of concern, and
- obtain closure for the existing Administrative Order.

The following sub-sections explain how each of the investigation activities contribute to these ends.

This Phase II program is designed to be implemented in phased fashion, with the results of each phase being used to establish the locations and analytical methods for subsequent phases. For instance, the results of the soil gas survey will be used to determine the shallow soil sampling locations, and the results of the shallow soil samples will be used to establish the deeper soil sampling and groundwater sampling locations and analytical program.

2.1 Existing Data Review

Existing data review and analysis will comprise a critical part of the Phase II investigation. Data from a wide variety of sources covering both the Omega site and other sites in the region will be reviewed to obtain information on:

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- site-related data,
- local and regional geology and hydrogeology,
- groundwater flow direction and velocity,
- water quality trends,
- potentially contributing up-gradient sources of hazardous substances, and
- the location of potential down-gradient receptors.

Data generated during previous investigations has already been reviewed, and this information has been incorporated into this workplan. Regional information obtained during the Phase II field program will be used in the evaluation and final determination of CPT/ HydroPunch™ sampling locations and analytical methods. Pertinent information from this review will also be considered in evaluating the significance of data obtained during the Phase II field program.

2.2 Shallow Soil Gas Survey

A shallow soil gas survey will be conducted to screen the site for volatile organic compounds. Soil gas surveys generate extensive chemical distribution data quickly at a fraction of the cost of conventional invasive methods, and have proven their value in early phases of site investigation by delineating source areas and guiding subsequent field work. One of the principal limitations of soil gas surveys is the potential for over-interpretation of the results. Vapor phase concentrations are rarely in equilibrium with concentrations in the soil, and as a result of gas phase diffusion or soil gas advection, the vapor plume usually covers a larger area than the source plume. The data, although quantitative by nature, are more valuable from a qualitative perspective. The method is a screening tool and the results must be considered in that light.

At the Omega site, the shallow soil gas survey is expected to provide the following information:

- horizontal extent of soil contamination,
- identification of "hot spots," and
- vapor concentrations in the vadose zone.

Figure 7 depicts the tentative soil gas sampling locations. Soil gas samples will be collected from two depths at each location, with a maximum depth of up to 12 feet bgs, which is the expected equipment limitation.

Soil gas samples from thirty locations will be analyzed by an on-site mobile laboratory for halogenated volatile organic compounds (HVOCs) and benzene, toluene, ethyl benzene and xylenes (BTEX). The California Regional Water Quality Control Board, Los Angeles Region (RWQCB), has prepared a list of Target Compounds for Active Soil Gas Investigations, which

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includes halogenated VOCs and BTEX. England/Hargis selected these as potential compounds of concern on the basis of site history and their relative mobility in the environment.

The HVOCs are particularly important target compounds, because the site activities were centered around the use of halogenated solvents and halogenated refrigerants. These materials were the most widely handled at the site, and are among the most mobile.

The results of the soil gas survey will be used to identify areas of elevated HVOCs and BTEX concentrations (hot spots), which will be subject to further investigation in shallow soil sampling, and will aid in selecting locations for HydroPunch™/BAT® groundwater sampling.

2.3 Shallow Soil Sampling

Hazardous wastes stored and treated at the site encompass a wider range of compounds than the VOCs addressed in the soil gas survey, and include semi-volatile organic compounds (SVOCs), pesticides and metals. Such compounds are generally much less mobile in the environment than VOCs, and if present, will likely be at their highest concentrations near the ground surface.

The nature and extent of such contaminants at the site will be determined by (1) sampling of "grossly contaminated" near-surface soil, concrete and asphalt pavements (if encountered), and (2) soil samples collected from hand augered borings to depths of up to 5 feet. Sample locations will be based on visual inspection, information on past uses of specific areas of the site, and results of the soil gas survey. Targeted locations include suspected source areas, such as the two sumps on the south side of the warehouse, the PVC pipe located on the east side of the warehouse, and the broken concrete patch located in the center of the loading dock (Figure 7).

Each of the one-foot samples from the shallow borings and the five-foot samples from near the sumps will be analyzed for VOCs, SVOCs, chlorinated pesticides and PCBs, and metals. The other five-foot samples will be analyzed for VOCs. In addition, SVOC and pesticide/PCB extractions will be performed to meet laboratory holding time criteria. If the one-foot sample in each boring tests positive for SVOCs, chlorinated pesticides and PCBs, or shows elevated metals concentrations, the five-foot sample will be analyzed as well for analytes detected at significant concentrations at the one-foot level. Additionally, the soil sample with the highest concentrations of contaminants will be analyzed using the Toxicity Characteristic Leaching Procedure (TCLP).

Two borings with the greatest contamination at the five-foot level will be targeted for follow-on soil sampling at greater depths using the CPT rig (Section 2.5.2).

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It is expected that the one-foot sample is adequate to detect "grossly contaminated" near-surface materials (soil, asphalt, or concrete). If such materials appear to be closer to the surface than one-foot, these will be sampled as well.

2.4 Location and Evaluation of Existing Well BMW-1

Monitoring well BMW-1 was drilled and installed by ENSR in 1988, and was apparently paved over when the concrete pad was constructed in 1988-89; its present condition is not known. Boring BMW-2 did not reach groundwater and was not completed as a well. If possible, well BMW-1 will be located and its condition evaluated. Following evaluation, a Technical Memorandum will be submitted to EPA outlining our recommendations for further action, if any is needed.

2.5 Deep Soil Sampling and Groundwater Sampling

Lithologic data at the site will be obtained using cone penetrometer testing (CPT) methodology. Additionally, deep soil samples and groundwater samples will be collected using the CPT rig. The CPT technology was selected for these activities because of the number of samples points that can be collected daily, the significant reduction in soil cuttings produced compared to drilling and the minimal impact to the site.

CPT like any other investigative techniques has certain limitations. The depth of penetration of the CPT rig is based on the lithology at a site. The use of CPT is not recommended at sites with fat clays, cemented zones, or gravel/cobble intervals. Lithologic data obtained during drilling of BMW-1 indicates that lithologic conditions are favorable, and the CPT rig should be able to reach the water table at 75 feet bgs.

The depth of base of the first water bearing unit is not known at the site, however, it is greater than 100 feet bgs, based on the lithologic log from BMW-1. It is believed that the CPT will not be able to penetrate to the base of the first water bearing unit, based on the equipment limitation.

2.5.1 Cone Penetrometer Testing

A cone penetrometer (CPT) rig will be used to assess the geology and hydrogeology of the site at the locations indicated on Figure 7. The information obtained will be used in assessing potential paths of contaminant migration.

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2.5.2 Deep Soil Sampling

Selected locations have been targeted for soil sampling at depths greater than five feet. The CPT rig will be utilized to collect soil samples at depths of approximately 50 feet and 70 feet bgs at the two most southerly locations depicted in Figure 7. In addition, the CPT rig will be used to collect follow-on samples in at least two points determined to be contaminated during the shallow soil sampling activity, as well as in the vicinity of the former UST (Figure 7). At these locations, samples will be collected at 15 feet bgs; field screening techniques will be used to determine whether to continue sampling at 15-foot intervals. Collected samples will be analyzed for VOCs, at a minimum.

2.5.3 Groundwater Sampling

The nature and extent of on-site groundwater contamination will be determined through collection of four on-site groundwater samples using the CPT- HydroPunch™/BAT® sampling method. Additionally, verifiable water levels will be obtained while collecting groundwater samples to evaluate localized hydraulic gradients.

One of the CPT-HydroPunch™/BAT® sampling points will be situated in the corner of the property near the former location of well BMW-1. The locations of the other three HydroPunch™/BAT® sampling points will be determined by the prevailing regional groundwater flow direction which will be ascertained during review and analysis of data obtained by that time. One groundwater sample will be collected in an up-gradient location, one in a cross-gradient location, and one in a down-gradient part of the site near an existing sump. Figure 7 depicts the four proposed groundwater sampling locations based on an assumed northeast-to-southwest groundwater flow direction. These sampling locations may be modified based on the results of the soil gas and shallow soil sampling.

The groundwater sample from near the former well will be analyzed for VOCs by EPA Method 8240. Additional analyses may be run if shallow soil sampling results indicate elevated concentrations of other compounds. Groundwater samples from the CPT HydroPunch™ /BAT® locations will be tested only for VOCs unless other sampling results indicate a need for more thorough testing.

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3.0 SCOPE OF WORK

3.1 Introduction

In order to accomplish the objectives outlined by the Administrative Order, and in accordance with the Approach described above, the five following tasks have been identified:

Sampling of Soil and Groundwater

1. Existing Data Review and Analysis
2. Shallow Soil Gas Survey
3. Shallow Soil Sampling
4. Location and Evaluation of Existing Well BMW-1
5. Deep Soil Sampling and Groundwater Sampling with Cone Penetrometer

The scope of these activities are described below. Health and safety procedures to be followed during field activities conducted at the site are defined in the Health and Safety Plan (Appendix B), while Standard Operating Procedures for each of these field activities are described in Appendix C. Quality Assurance procedures for field activities and laboratory analyses are discussed briefly in Section 4.0, and in greater detail in Appendix D. A summary of the sample analytical schedule for each type of sample is presented in Table 1.

Table 1
Sample Analytical Schedule

Sample Matrix	Sample Location	Analytical Schedule ⁽¹⁾
Soil Gas	All locations.	RWQCB List, 23 compounds includes HVOCs and BTEX by Mobile Laboratory.
Shallow Soil	All 1-ft samples.	VOCs, SVOCs, Pesticide/PCBs, and Metals.
	5-ft samples collected adjacent to the two sumps.	VOCs, SVOCs, Pesticide/PCBs, and Metals.
	All remaining 5-ft samples.	VOCs initially, SVOCs and Pesticide/PCBs perform extractions. Analyze for one or more SVOCs, Pesticides/PCBs, and/or Metals if significant concentration is detected in the corresponding overlying sample.

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Sample Matrix	Sample Location	Analytical Schedule ⁽¹⁾
Shallow Soil (Cont.)	"Grossly contaminated" soil, asphalt, or concrete.	It is anticipated that the one-foot sample will provide sufficient information. However, if additional near surface analysis is required then samples would be analyzed for VOCs, SVOCs, Pesticide/PCBs, and Metals.
Deep Soil	Sample collected in vicinity of former UST excavation at 15 feet bgs (Sample C-1).	VOCs, SVOCs, Pesticide/PCBs, and Metals
	Additional samples collected at this location at 15-ft increments based on field screening results.	VOCs
	Follow on samples collected at 15 feet bgs at sample point where significant amount of contamination was detected in a 5-ft sample.	VOCs at a minimum, other analytes will be based on results of overlying sample analysis.
	Additional samples may be collected at 15-ft intervals in the vadose zone field screening results indicate significant contamination.	VOCs.
Groundwater	Soil samples will be collected at 50- and 70-feet bgs at two locations (Samples H-1, H-4).	VOCs.
	CPT boring near monitor well BMW-1 (Sample H-1).	VOCs, other analysis will be performed if soil samples in this vicinity have significant levels of contamination.
	Three remaining CPT borings (Samples H-2, H-3, H-4).	VOCs

- | | | |
|---------------------|---|--|
| (1) CPT | = | Cone Penetrometer test. |
| HVOC | = | Halogenated volatile organic compound analysis using EPA Method 8010. |
| SVOC | = | Semi-volatile organic compound analysis using EPA Method 8270. |
| VOC | = | Volatile organic compound analysis using EPA Method 8240. |
| Pesticides and PCBs | = | Organochlorine pesticides/polychlorinatedbiphenyl using EPA Method 8080. |
| Metals | = | See Table 5, Appendix D. |

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3.2 Review of Regional Hydrogeologic Data

Regional hydrogeologic data will be collected in addition to the existing site investigation data discussed in Section 1.4. A regional hydrogeologic evaluation will be conducted to characterize the geologic setting and hydrogeologic conditions of the Montebello Forebay at the site and in its vicinity. An additional objective of this evaluation is to identify known and potential sources of groundwater contamination in the vicinity of the site. This evaluation will be conducted using existing information that has been published or is otherwise available from public or private sources.

Types and sources of information that will be obtained and evaluated include the following:

- Information regarding existing and former production wells, observation wells, and monitor wells within a 2-mile radius of the site. Information to be obtained includes well identifiers, locations, and depths, construction specifications, lithologic or driller's logs, water level data, historic and current usage data, and, if available, aquifer parameter data. Potential sources of well information include the California Department of Water Resources (DWR), reports and maps issued by the DWR Southern District Watermaster (Watermaster), and files maintained by the RWQCB. This information will be supplemented by annual reports of Water Resources Data for California, published by the U.S. Geological Survey (USGS). Water level data will also be obtained from maps published by the Los Angeles County Flood Control District.
- Regional hydrogeologic reports will be obtained to characterize geologic and hydrogeologic conditions of this portion of the Central Basin. These reports include hydrogeologic investigations conducted by the USGS and DWR.
- Regional water quality will be evaluated using data obtained from DWR, from annual USGS reports of Water Resources Data for California, and from Annual Water Quality Reports published jointly by the West Basin Municipal Water District and the Central Basin Municipal Water District. These reports provide data regarding both organic and inorganic water quality.
- Information regarding alternate sources within a 1-mile radius of the site will be evaluated. A comprehensive search of regulatory agency databases will be conducted by Vista Environmental Information, Inc., San Diego, California. Based on the results of the database search, additional information regarding potential alternate sources in the site vicinity will be obtained from file reviews at federal, state, and local agencies. File review inquiries, as appropriate, will be made at offices of the EPA, the California Environmental Protection Agency Department of Toxic Substances Control (DTSC),

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RWQCB, Los Angeles County Department of Public Works (LACDPW), the City of Whittier, and the local fire department.

- A Phase I closeout report is being prepared by Harding Lawson and Associates. Any relevant data from that report will be included in the Phase II evaluation.
- Existing site investigation documents, including the soil gas survey letter report prepared by ERT (AR 6), and the *Report on Site Assessment Investigations at Omega Recovery Facility*, prepared by ENSR (AR 7), have been evaluated, and will be included in the interpretation.
- Additionally, an interview with the site owner, Mr. O'Meara, should be planned by EPA to obtain information regarding existence of plans for the concrete pad, location of sewer lines, the monitor well, and other subsurface items of which he may be aware.

Information gathered during the data evaluation described above will be utilized as follows:

- Characterize the geology and hydrogeologic units occurring at the site and in its vicinity.
- Determine groundwater elevations, flow directions, and gradients in the site vicinity.
- Estimate aquifer parameters of hydrogeologic units underlying the site vicinity, including transmissivity, hydraulic conductivity, storativity, and specific capacity.
- Estimate groundwater flow velocity in the site vicinity.
- Characterize organic and inorganic water quality in the vicinity of the site.
- Locate and conduct a preliminary evaluation of potential sources of contamination within a one-mile radius of the site.
- Define down-gradient receptors of contaminants in the vicinity of the site.

This evaluation is intended to determine the need for additional investigation and to focus those investigations appropriately. This information will be used to determine groundwater sampling locations and methods, where applicable.

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3.3 Shallow Soil Gas Survey

In order to determine the horizontal extent of soil contamination by halogenated VOCs and BTEX, a shallow soil gas survey will be performed. Standard Operating Procedures (SOPs) for the soil gas survey are outlined in Appendix C. The survey will be conducted according to the guidelines established by the RWQCB in their *Requirements for Active Soil Gas Investigation*, (March 1994). A copy of this document has been included as Appendix E. Standard operating procedures and QA/QC procedures of HydroGeoChem are included as Appendix F.

3.3.1 Sampling Locations and Analytes

Twenty-five locations have been selected for sampling, based on an approximate 50-foot grid, and an additional five samples based on former site activities or surface features (Figure 7). The selected sampling grid was chosen to provide site-wide coverage; if the results of sampling indicate contamination and greater resolution of the lateral extent is desired, then additional sampling points can be added at the discretion of the OPOG Project Coordinator. Individual sample locations may be shifted based on access limitations and field observations of possible "hot spots" or pathways to the subsurface. Soil gas sample locations have been added or moved to target the two sumps at the south end of the warehouse; the PVC pipe in the ground inside the bermed area east of the warehouse; the square, damaged concrete patch on the floor of the loading dock; and the southwest corner of the property.

Soil gas samples will be collected at approximate six (6) and twelve (12) foot depths at each sampling location, and analyzed for halogenated VOCs and BTEX using an on-site mobile laboratory. The target depths of 6 feet and 12 feet are based upon expected equipment limitations at the site. If site conditions permit, and if justified by analytical results, samples will be collected from greater depths.

The specific suite of analytes is based upon the guidelines established by the Regional Water Quality Control Board, Los Angeles Region (RWQCB, 1994), and includes the following 23 target compounds (Appendix E):

carbon tetrachloride	chloroethane	chloroform	1,1-dichloroethane
1,2-dichloroethane	1,1-dichloroethene	cis-1,2-dichloroethene	trans-1,2-dichloroethene
methylene chloride	tetrachloroethene (PCE)	1,1,1,2-tetrachloroethane	1,1,2,2-tetrachloroethane
1,1,1-trichloroethane	1,1,2-trichloroethane	trichloroethene	vinyl chloride
benzene	toluene	ethylbenzene	xylene
trichlorofluoromethane (Freon 11)	dichlorodifluoromethane (Freon 12)	1,1,2-trichloro-trifluoroethane (Freon 113)	

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The potential contaminants represented by this target list are volatile and generally mobile; their use as analytes will provide a good indication of the maximum extent of soil contamination by VOCs. The data collected will be used to assess whether existing site conditions present an immediate threat to public health.

3.4 Shallow Soil Sampling

The nature and extent of shallow soil contamination will also be determined through collection of soil samples from shallow, hand-augered borings.

3.4.1 Sampling Locations and Analytes

Preliminary locations are indicated on Figure 7, but are subject to change based upon site conditions and the results of the shallow soil gas survey. Upon completion of the soil gas survey, a Technical Memorandum will be submitted to the EPA detailing the proposed locations for soil sampling. These will be reviewed in consultation with EPA to select the final number and location of sample points. Samples will be collected from each hand-auger boring at depths of one (1) and five (5) feet bgs. For each of the two sumps, the samples will be taken from one foot and five feet below the bottom of the sump.

Targeted locations include suspected source areas, such as the two sumps on the south side of the warehouse, the PVC pipe located on the east side of the warehouse, and the broken concrete patch located in the center of the loading dock (Figure 7). If soil gas screening tests do not show significant concentrations at any of these locations, the shallow borings may not be done at that location.

All of the one-foot samples and the two five-foot samples near the two sumps will be analyzed for VOCs (EPA Method 8240), SVOCs (EPA Method 8270), chlorinated pesticides and PCBs (EPA Method 8080), and metals (CCR T22). Five-foot samples will be analyzed by Method 8240, although 8270 and 8080 extractions will be performed to meet laboratory holding time criteria. Note, the metals samples have a six-month holding time and therefore no preparation work is necessary. If the one-foot sample in each boring tests positive for SVOCs, chlorinated pesticides, PCBs, or metals, the five-foot sample will be analyzed as well. The analytical results for VOCs in the soil will be compared with the results of soil gas analyses at nearby sampling locations.

Borings with contamination at the five-foot level will be targeted for follow-on soil sampling at greater depths using the CPT rig (§3.6.2).

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If "grossly contaminated" near-surface materials (soil, asphalt, or concrete) are discovered at less than one-foot bgs, samples of these materials will be collected and subjected to the same analyses described above.

3.5 Location and Evaluation of Existing Well BMW-1

Monitoring well BMW-1 was drilled and installed by ENSR in 1988, and has subsequently been paved over; the present condition of the well is not known. If possible, well BMW-1 will be located and evaluated. After evaluation, a Technical Memorandum will be issued to EPA documenting our recommendations regarding further activities with respect to this well.

3.5.1 Geophysical Survey and Evaluation

Although its *approximate* location is known, well BMW-1 has been covered by an unknown thickness of pavement. Geophysical techniques, including GPR and EM surveys, will be used in an attempt to pinpoint the well's location. Once the well has been located, the surrounding and overlying pavement will be cut to expose the wellhead, and the condition of the well will be evaluated. If it appears that the well is a potential conduit for contaminant migration, a Technical Memorandum will be prepared recommending abandonment. Upon approval of the Technical Memorandum by the EPA, the well will be properly abandoned in accordance with the guidelines of LACDPW, and the California Department of Water Resources.

3.6 Deep Soil Sampling and Groundwater Sampling

3.6.1 Cone Penetrometer Testing (CPT)

A cone penetrometer (CPT) rig will be used to assess the geology and hydrogeology of the site at the locations indicated on Figure 7. Four exploratory soundings will be advanced using a Cone Penetrometer Test (CPT) rig. Detailed geologic and hydrogeologic information can be obtained through interpretation of data gathered as the instrumented CPT cone is forcibly pushed into the formation. The probe is capable of measuring tip resistance, frictional sleeve resistance, electrical resistivity in soil and groundwater, and pore pressure, and is capable of gathering groundwater samples (Appendix G). Electrical resistivity will allow for free product to be determined if the free product phase is greater than 1-2 inches in thickness.

3.6.2 Deep Soil Sampling

Selected locations have been targeted for soil sampling at depths greater than five feet. The CPT rig will be utilized to collect soil samples at depths of approximately 50 feet and 70 feet bgs at the two most southerly locations depicted in Figure 7 (H-1 and H-4). In addition, the CPT rig

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will be used to collect follow-on samples in at least two areas determined to be contaminated during the shallow soil sampling activity, as well as in the vicinity of the former UST (C-1, Figure 7). At these locations, samples will be collected at 15 feet bgs; field screening techniques will be used to determine whether to continue sampling at 15-foot intervals. Collected samples will be analyzed for VOCs by EPA Method 8240. Other analyses will be added if the nearby samples at five feet show significant concentration of other analytes.

3.6.3 HydroPunch™/BAT® Groundwater Sampling Locations

The four proposed CPT locations are depicted in Figure 7 (H-1 through H-4). The four locations have been selected to provide widespread coverage of the site. Groundwater samples collected from these locations will provide an indication as to the degree and distribution of groundwater contamination. Groundwater samples will be collected from each sounding location for laboratory analysis. Samples will be collected using a HydroPunch™ or BAT® groundwater sampling device. Manufacturers' information on these systems is included in Appendix G.

If practicable, in-situ pore pressure information will be used to determine groundwater elevation in each sounding, thereby providing valuable information on local groundwater gradient and possible avenues for contaminant migration.

Water level data will be obtained using the BAT-Enviro Probe system. Once the BAT-Enviro Probe system is installed to a depth of 5 to 10 feet below the water table, a pressure transducer will be used to obtain water level data. Water level data will be monitored until static conditions are reached. Groundwater samples will then be collected and the water levels will once again be monitored until static conditions are reached. It is anticipated that water level data with an accuracy of ± 0.1 feet will be obtained. Land surface elevations at each groundwater sampling location will be surveyed to an accuracy of ± 0.01 feet. Alternative methods to obtain water levels, if necessary, include the installation of a temporary 3/4-inch piezometer.

3.6.3.1 *Laboratory Analyses of Groundwater Samples*

Groundwater sample H-1, from near former well BMW-1, will be tested for VOCs by EPA Method 8240 and for other analytes if soil sample analyses show significant concentrations of other compounds. The suite of analyses for the other three groundwater samples from the CPT locations will depend upon the results of analyses performed on groundwater sample H-1. These analyses will include EPA Method 601/8010 for halogenated VOCs, and may include additional analyses if the first CPT groundwater sample exhibits high concentrations of other compounds.

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3.7 Analytical Laboratory and Soil Gas Contractor

Analytical services will be provided by BC Analytical (BCA, Anaheim, California), a State-certified environmental laboratory. BCA's fixed location laboratory in Anaheim will provide analyses of soil, groundwater, and pavement materials. Sample turn-around time is anticipated to be five to ten working days.

Duplicate soil and groundwater samples will be processed by Del Mar Analytical (Irvine and Colton, California), a State-certified environmental laboratory.

Soil gas sample collection and analyses will be performed by HydroGeoChem, Inc. (Huntington Beach, California), a soil gas specialty contractor. Soil gas analyses will be performed on-site in HydroGeoChem's mobile laboratory.

Quality assurance/quality control (QA/QC) documentation for BCA is included as Appendix H and documentation for HydroGeoChem is included in Appendix F.

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4.0 QUALITY ASSURANCE PROGRAM

A quality assurance program has been prepared for this investigation, in accordance with U.S. Environmental Protection Agency (EPA) guidelines (EPA, 1987, 1989a, and 1994c). Appendix D of this Workplan provides a detailed description of the Quality Assurance/Quality Control (QA/QC) procedures for the collection, identification, preservation, and transport of samples collected during the investigation; the calibration and maintenance of instruments; and the verification, storage, and reporting of data, including chain-of-custody procedures. Additionally, Appendix D identifies the QA project organization. The following analytical laboratories have been selected for this investigation: BC Analytical, Anaheim, California; Del Mar Analytical, Irvine and Colton, California; and HydroGeoChem, Inc., Huntington Beach, California.

The purpose of the quality assurance program is to identify data quality objectives (DQOs) and to provide a framework for collecting data that meet the DQOs. DQOs are initially identified during project scoping and are intended to provide implementable objectives that ensure that the data obtained during field activities are of a quality consistent with their intended uses. The DQOs are qualitative and quantitative statements that identify the minimum level of data QA necessary to meet the intended uses of the data to be collected. Major data use categories for data obtained during field sampling, field measurement, and testing activities are summarized in Appendix D. QA objectives have been established for each activity to provide criteria for evaluating the measurement process to ensure that the resultant data satisfy each DQO established for that activity.

QA is defined as the integrated program designed to ensure that DQOs are met. QC is a component of the QA program and is defined as the routine use of standard procedures to conform to prescribed performance criteria in the monitoring and measurement process. QC procedures are established on the basis of DQOs. The QC procedures contained in Appendix D are intended to ensure that site investigation activities are performed in accordance with professional standards, government regulations and guidelines, and specific project goals, DQOs, and requirements. Standard operating procedures (SOPs) have been developed to ensure that samples are collected in a manner consistent with the QA program.

QC procedures have been developed for field activities and laboratory analyses to ensure that samples are collected and analyzed in a manner consistent with the DQOs. Field QC procedures have been prepared for field instrument and equipment calibration, sample collection, and field parameter measurements (Appendix D). Laboratory QC procedures used for the analysis of samples collected as part of field activities have been provided by the individual laboratories (Appendices F and H). Data quality will be assessed to determine if soil and groundwater samples were collected and analyzed in a consistent and appropriate manner. The quality and appropriate use of all data collected during site investigation activities will be determined based

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on data assessment and validation procedures. Field data will be assessed by the designated task manager for each specific task. Laboratory analytical data will be assessed under the supervision of the task manager.

This data quality management program is designed to ensure that QC procedures are adhered to from data collection to report preparation. Data obtained during sampling and field measurement activities will be used to make decisions with regard to sampling activities. Data quality management will be initiated prior to data collection by implementing QC procedures established to ensure that all data are obtained and analyzed in a manner consistent with QA objectives and are representative of the actual site conditions. Appendix D summarizes field and laboratory data quality management and assessment for project activities.

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5.0 REFERENCES

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- _____, 1994c. *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations*. EPA QA/R-S, August 1994.
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_____, 1995b. *First Amendment to Administrative Order 95-15*. September 1995.

California Regional Water Quality Control Board, Los Angeles Region, 1994. *Requirements for Active Soil Gas Investigation*. March 1994.

Administrative Record Documents:

- AR 3 *Investigation of Subsurface Soil Contamination at Tank Farm, Omega Chemical Corporation, Leroy Crandall and Associates, June 26, 1985.*
- AR 4 *Results of Laboratory Analysis Performed on Soil Samples Collected After the Removal of an Underground Tank. . . , Leighton and Associates, August 26, 1987.*
- AR 6 *Report on Soil Vapor Survey. . . , Environmental Research & Technology (ERT), February 2, 1988.*
- AR 7 *Report on Site Assessment Investigations at Omega Recovery Facility. . . , ENSR Consulting & Engineering, October 1988.*
- AR 38 *Interim Measures Removal Action Workplan, Omega Chemical Corporation. . . , Draft, IT Corporation, March 3, 1994.*



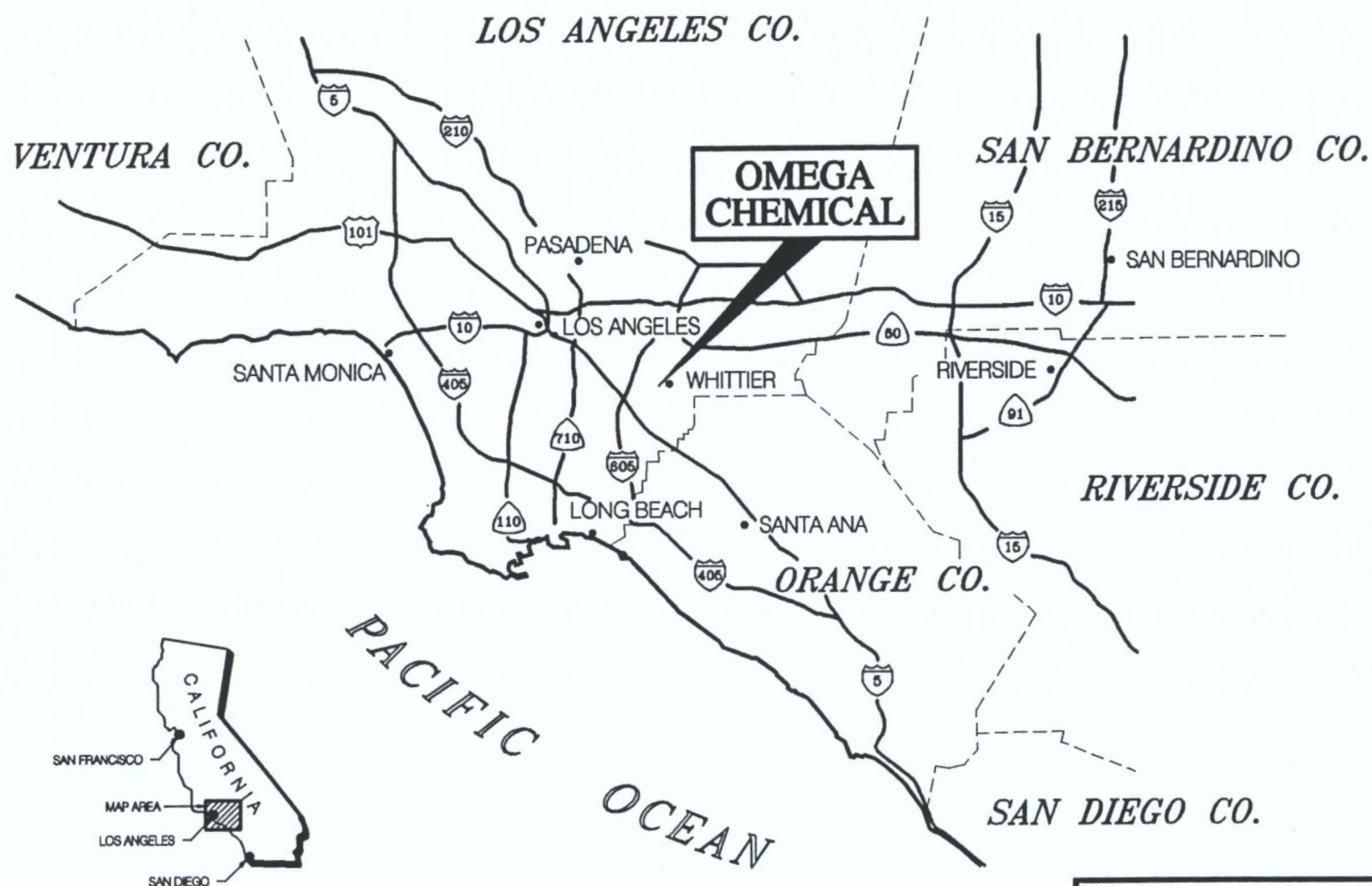


FIGURE 1

REGIONAL SITE LOCATION

OMEGA CHEMICAL
WHITTIER, CALIFORNIA

PREPARED FOR

OPOG

ENGLAND & ASSOCIATES

HARGIS + ASSOCIATES, INC.

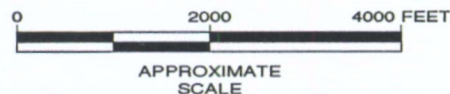
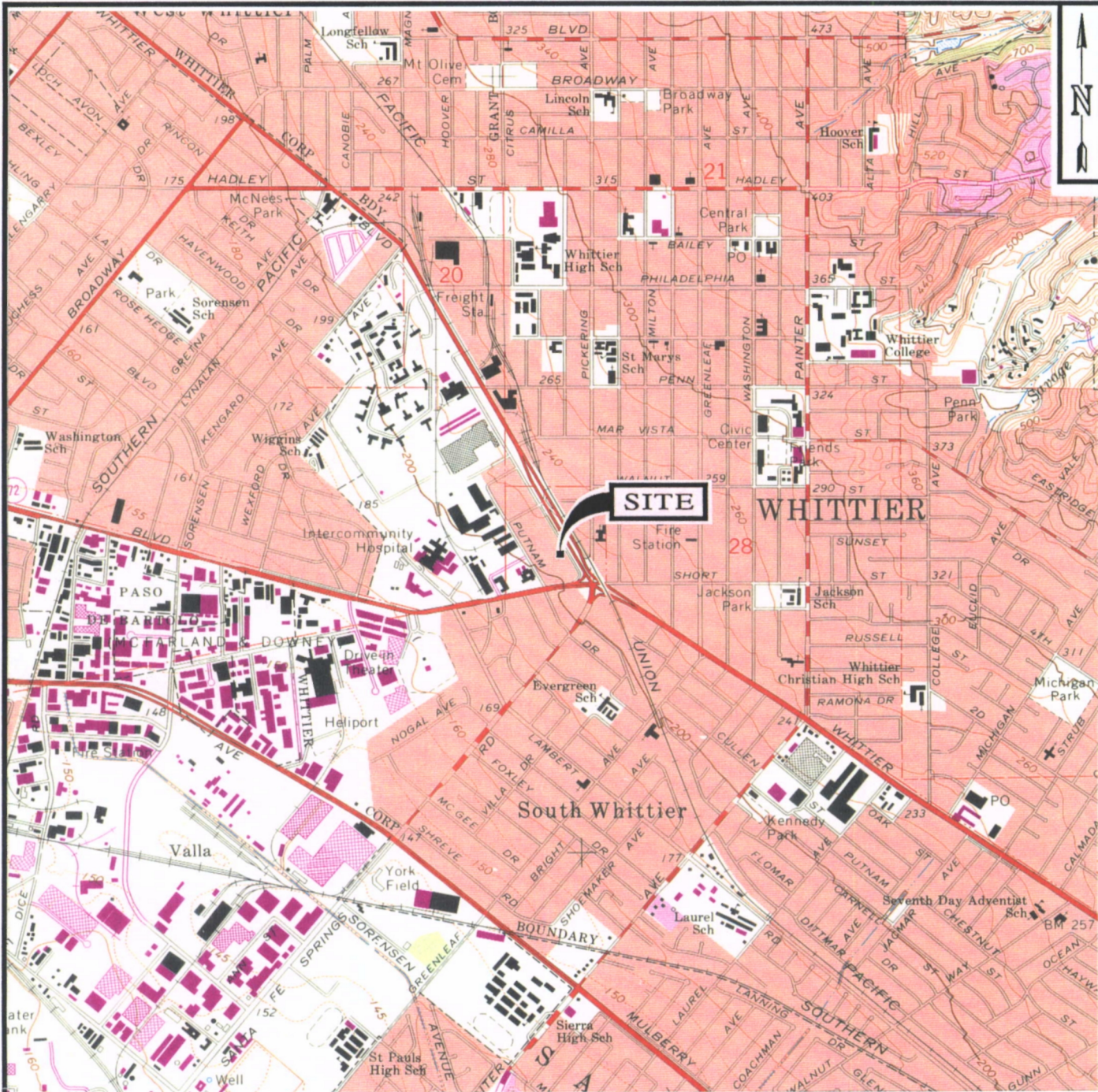


FIGURE 2

SITE LOCATION MAP

OMEGA CHEMICAL
WHITTIER, CALIFORNIA

PREPARED FOR
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HARGIS+ASSOCIATES, INC.

REFERENCE:
7.5 MINUTE U.S.G.S. TOPOGRAPHIC
MAP OF WHITTIER, CALIFORNIA
DATED: 1965
PHOTOREVISED: 1981

WHITTIER BOULEVARD



ANTICIPATED
GROUND WATER
FLOW DIRECTION
↓

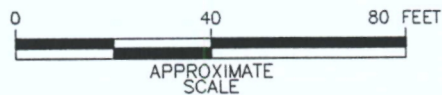
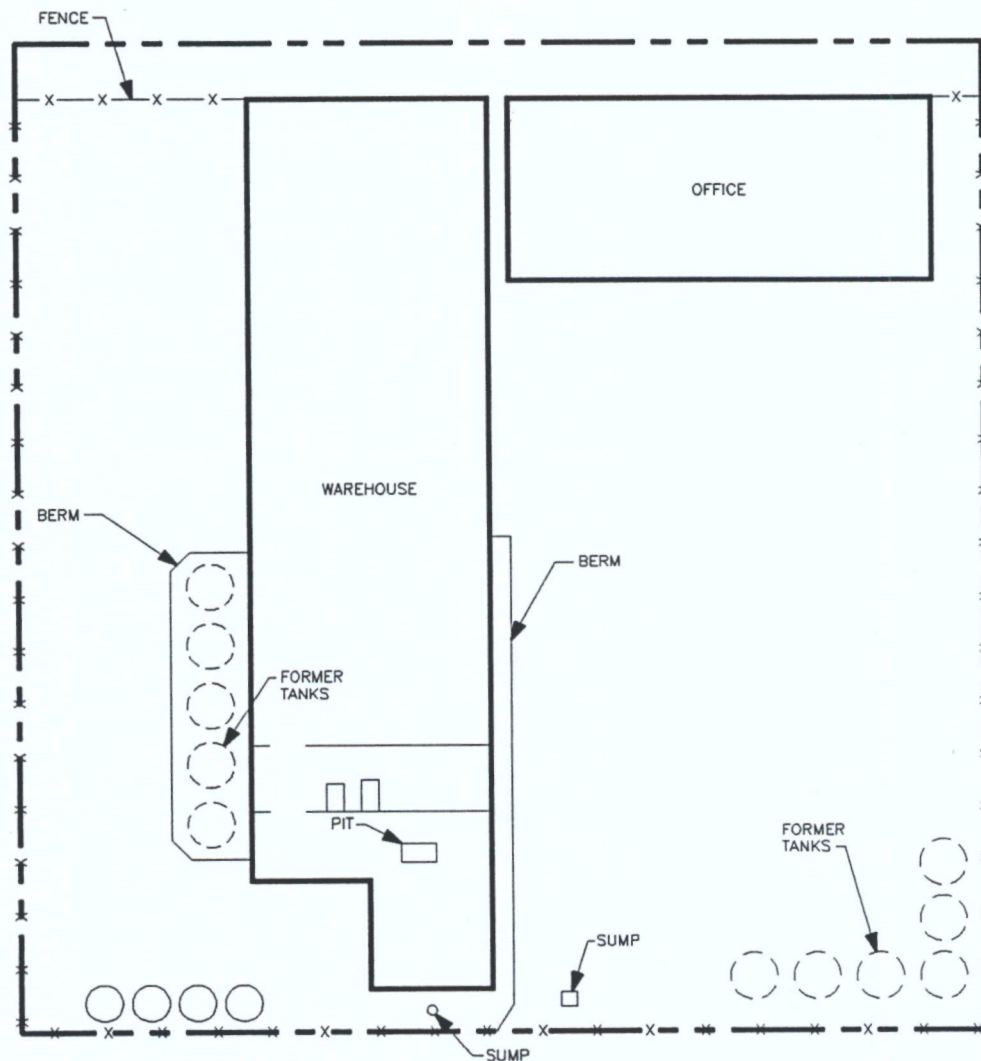


FIGURE 3

SITE PLAN

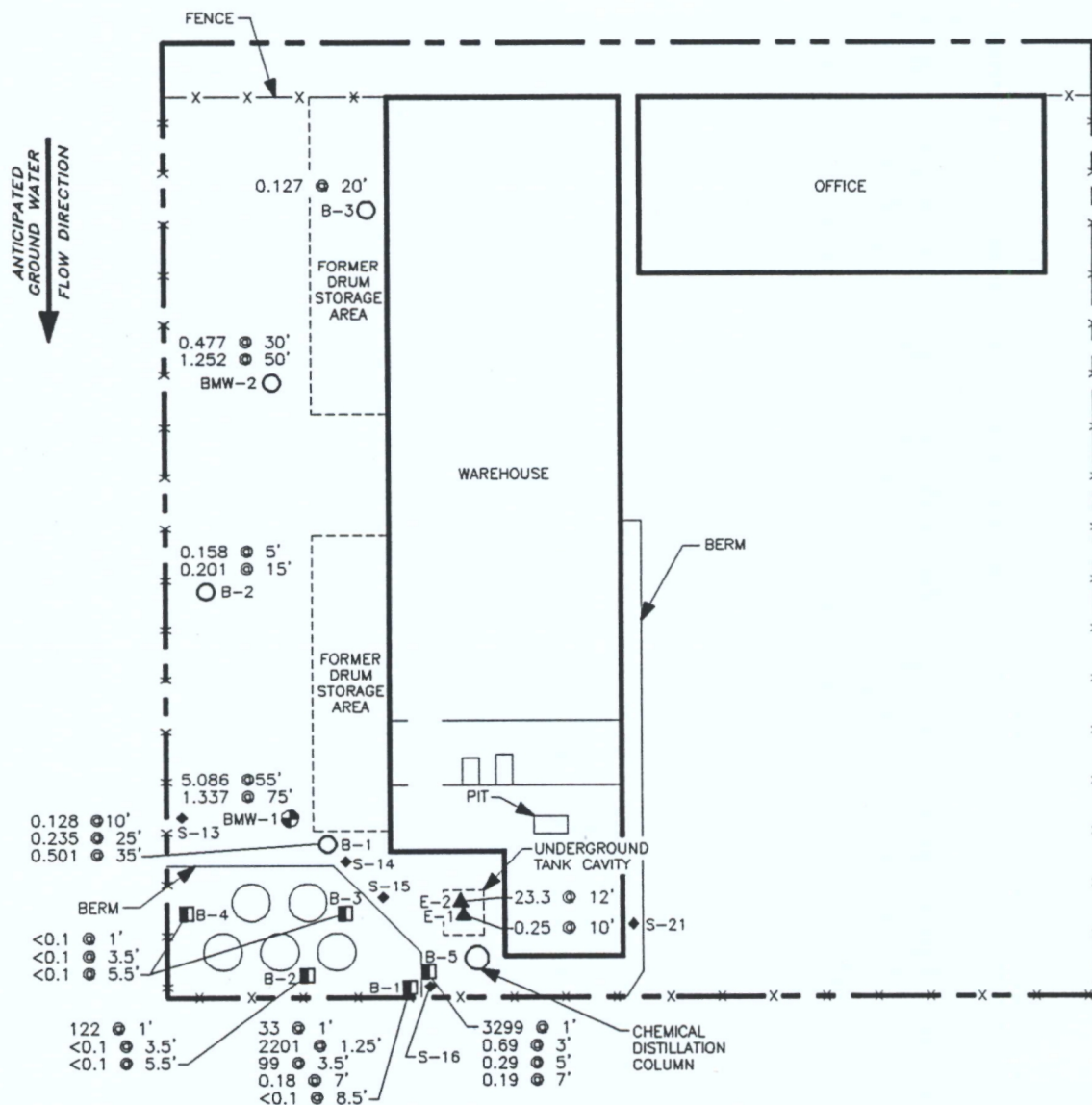
OMEGA CHEMICAL
WHITTIER, CALIFORNIA
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HARGIS + ASSOCIATES, INC.

NOTE:
ALL LOCATIONS APPROXIMATE.

WHITTIER BOULEVARD



EXPLANATION

- B-2 ○ ENSR SOIL BORING 1988
- BMW-1 ● ENSR GROUND WATER MONITORING WELL 1988
- E-2 ▲ LEIGHTON SOIL SAMPLE 1987
- B-5 □ LEROY CRANDALL BORING 1985
- S-21 ◆ ERT SOIL GAS SAMPLING POINT 1988

SAMPLE CONCENTRATION AND DEPTH IN FEET, CONCENTRATIONS ARE PPM OF TOTAL DETECTED VOCs. LEROY CRANDALL DATA INCLUDES ONLY 5 CHLORINATED VOCs AND NO CFCs

NOTE:
ALL LOCATIONS APPROXIMATE.

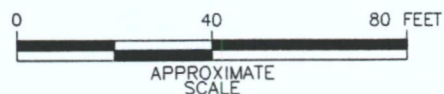


FIGURE 4
PREVIOUS
SAMPLING LOCATIONS
AND TOTAL
VOC CONCENTRATIONS
OMEGA CHEMICAL
WHITTIER, CALIFORNIA
PREPARED FOR
OPOG

ENGLAND & ASSOCIATES
HARGIS + ASSOCIATES, INC.

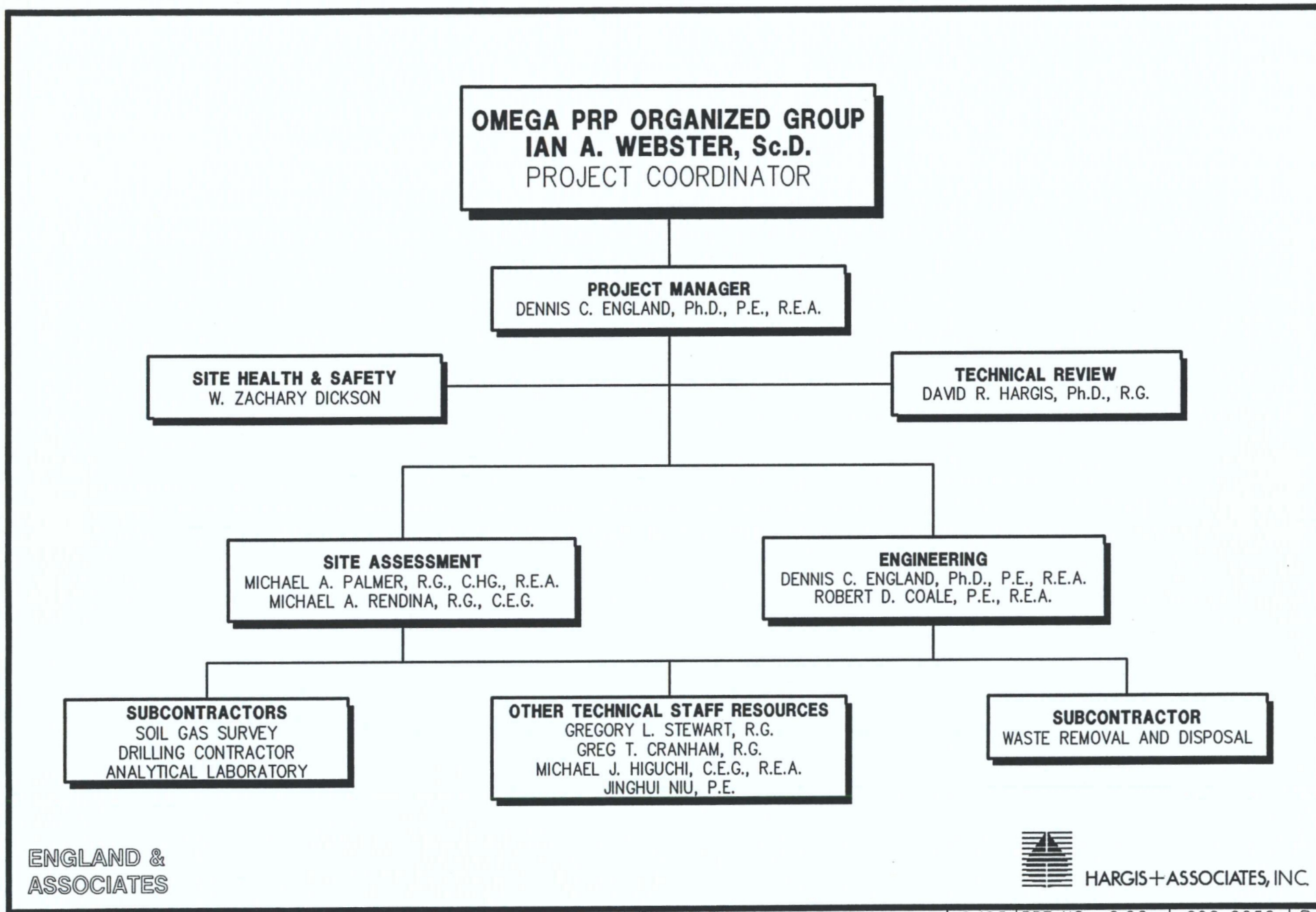
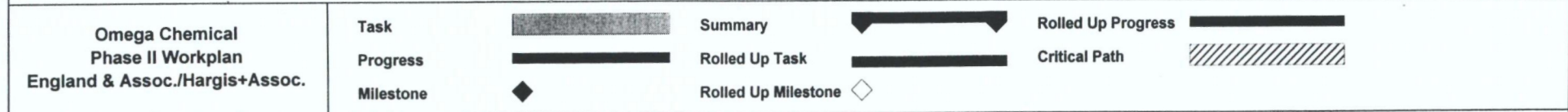
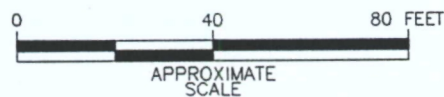
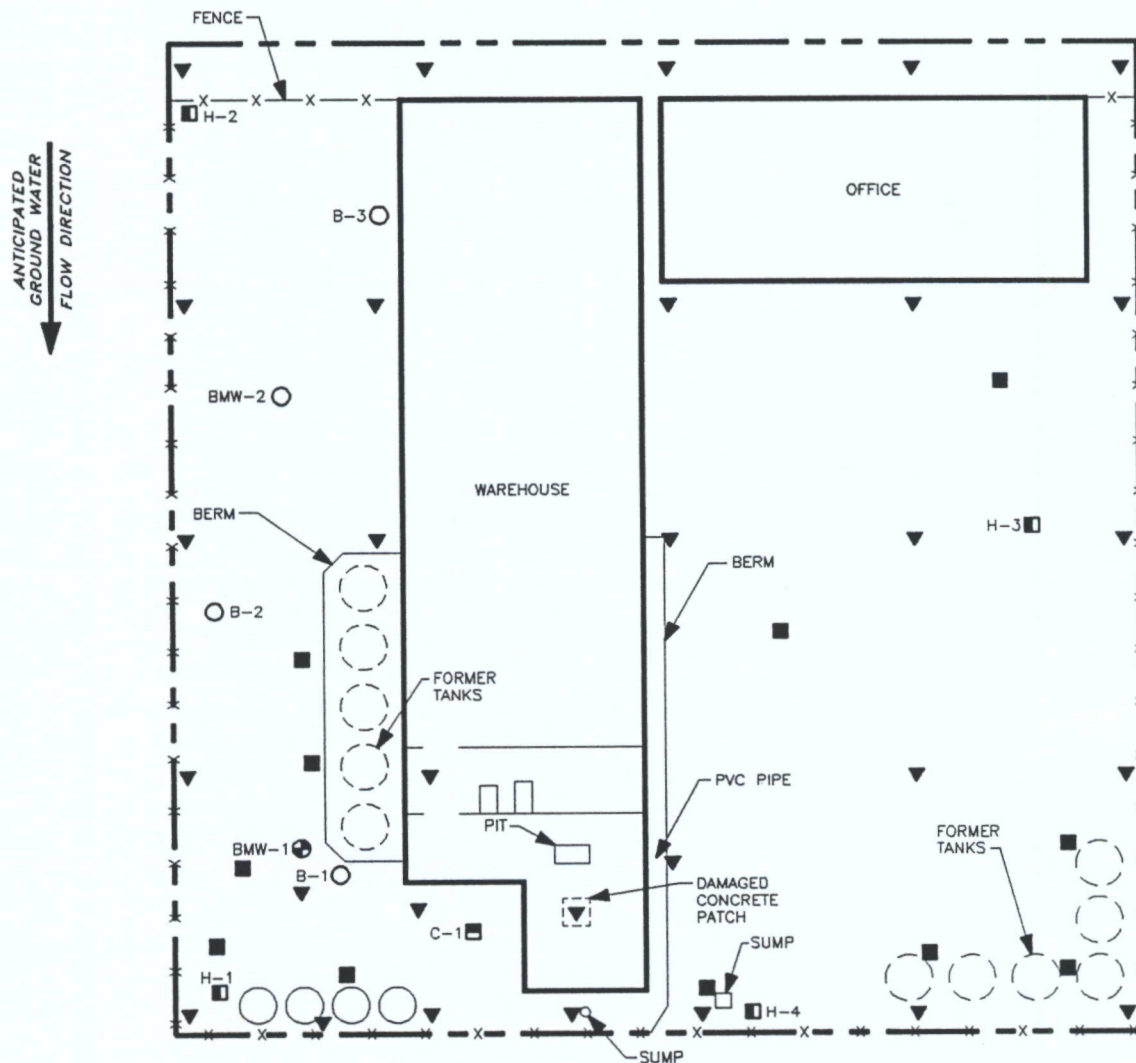


FIGURE 5 PROJECT ORGANIZATION

10/27/95



WHITTIER BOULEVARD



EXPLANATION

- B-2 ○ ENSR SOIL BORING
- BMW-1 ⊕ ENSR GROUND WATER MONITORING WELL
- ▼ PROPOSED SOIL GAS SAMPLE POINT
- PROPOSED SHALLOW SOIL BORING
- H-4 ■ PROPOSED HYDRO PUNCH/BAT SAMPLE POINT
- C-1 ■ PROPOSED CPT SOIL SAMPLE WITHOUT HYDRO PUNCH

NOTE:

ALL LOCATIONS APPROXIMATE AND
SUBJECT TO FIELD ADJUSTMENT.

FIGURE 7

PROPOSED
SAMPLING LOCATIONS

OMEGA CHEMICAL
WHITTIER, CALIFORNIA

PREPARED FOR
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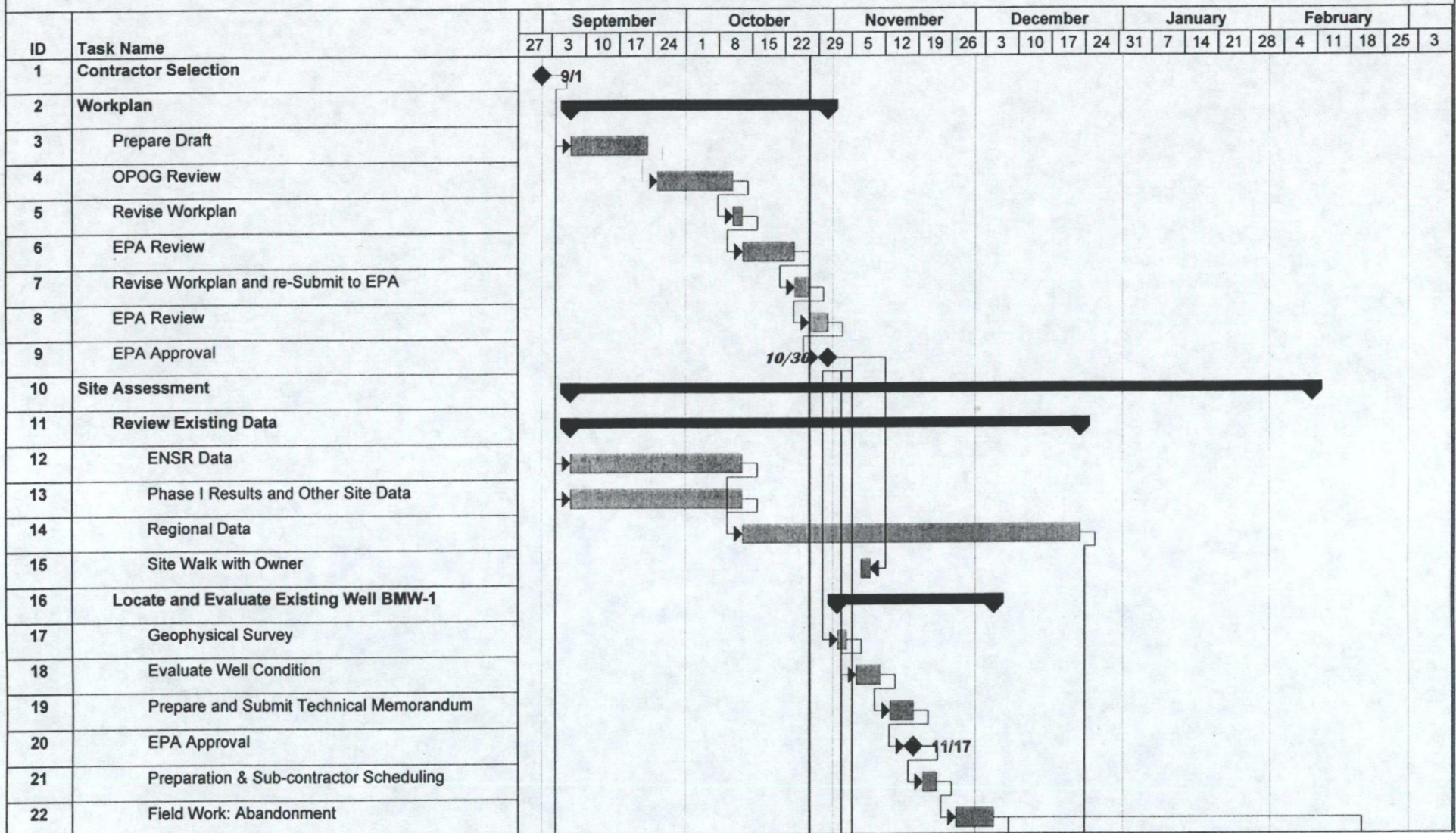
ENGLAND & ASSOCIATES

HARGIS + ASSOCIATES, INC.


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OMEGA CHEMICAL PHASE II SCHEDULE


10/27/95





Omega Chemical
Phase II Workplan
England & Assoc./Hargis+Assoc.


Task 


Progress 


Milestone 

Summary 

Rolled Up Task 

Rolled Up Milestone 

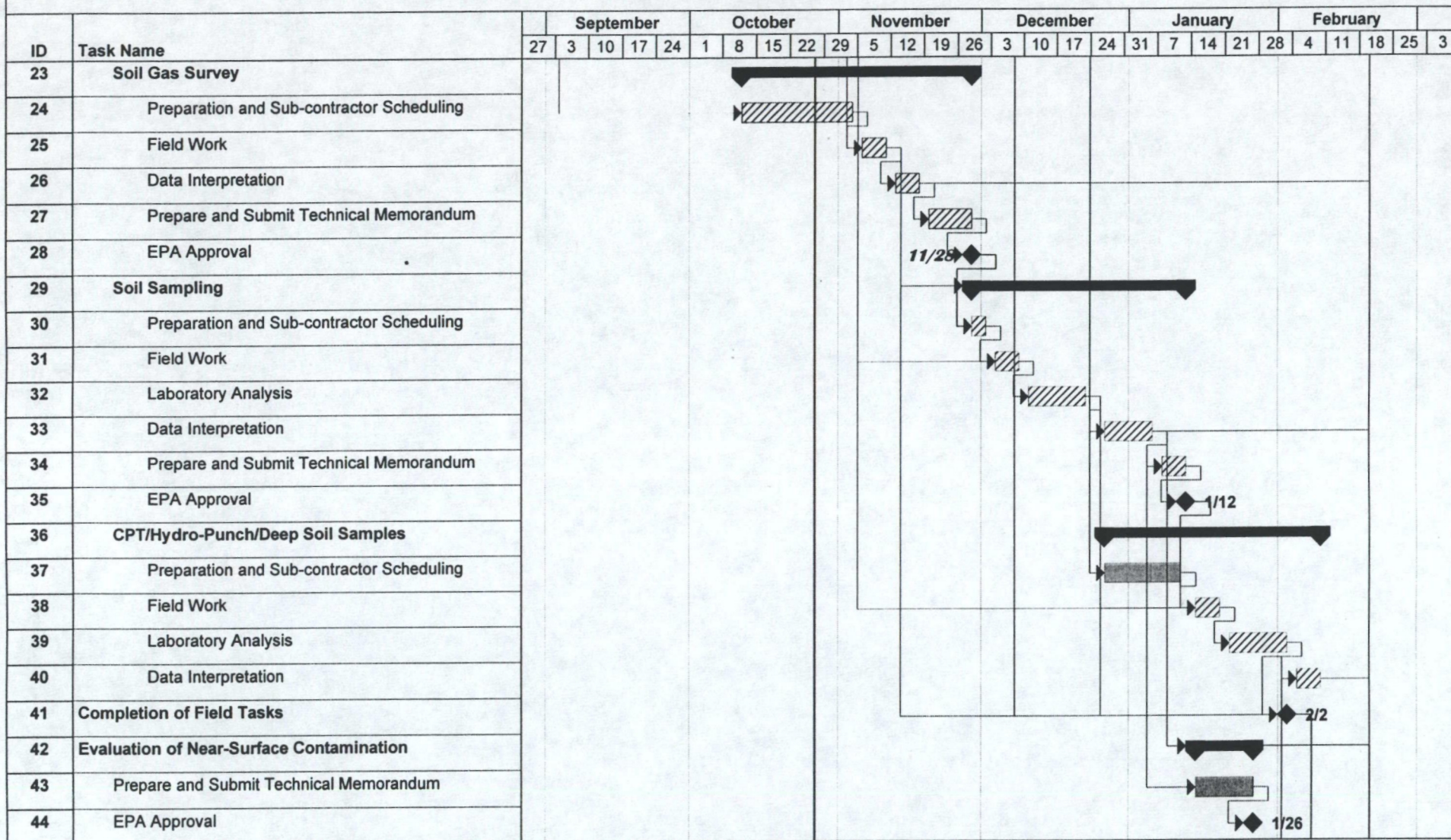
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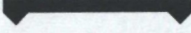

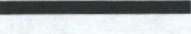

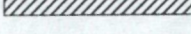


Critical Path 

Page 1 of 3

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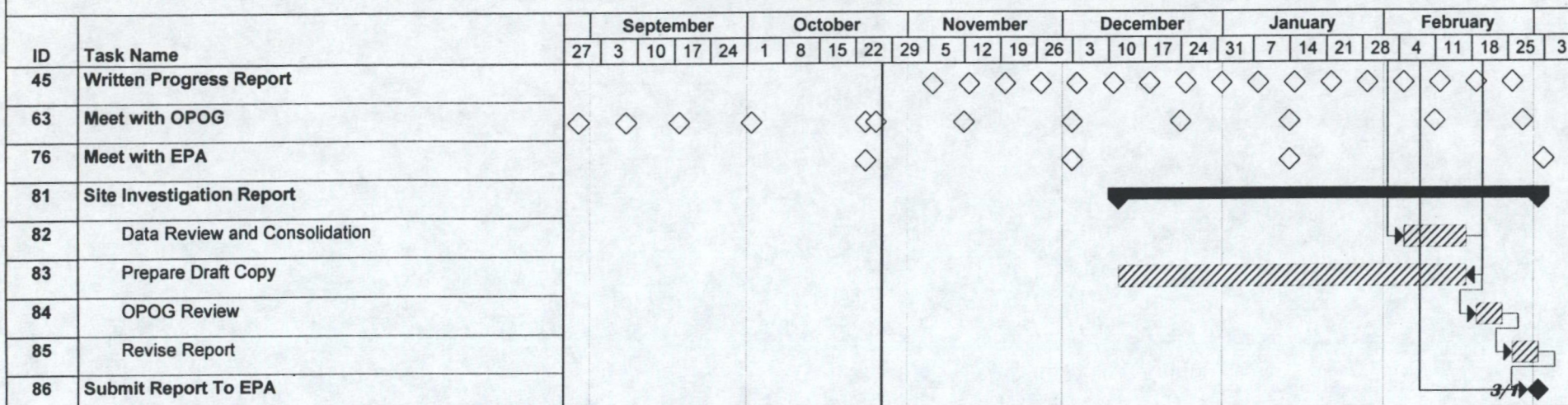
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Omega Chemical Phase II Workplan England & Assoc./Hargis+Assoc.	Task		Summary		Rolled Up Progress	
	Progress		Rolled Up Task		Critical Path	
	Milestone		Rolled Up Milestone			

OMEGA CHEMICAL PHASE II SCHEDULE

10/27/95



Omega Chemical Phase II Workplan England & Assoc./Hargis+Assoc.	Task		Summary		Rolled Up Progress	
	Progress		Rolled Up Task		Critical Path	
	Milestone		Rolled Up Milestone			

Appendix B



HEALTH & SAFETY PLAN
Omega Chemical Site
12504 and 12512 East Whittier Boulevard
Whittier, California
Project No. 399-A

PREPARED FOR

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October 27, 1995

HEALTH & SAFETY PLAN
Omega Chemical Site PRP Organized Group
Whittier, California

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1.0 INTRODUCTION

The Omega Chemical Site is located at 12504 and 12512 East Whittier Boulevard, Whittier, California. Collection of soil and ground water samples beneath the property has indicated the presence of purgeable organic compounds. The compounds detected and associated maximum concentrations in the soil and ground water are presented below.

<u>CAS No.</u>	<u>Compound (Common Synonyms)</u>	<u>Soil/Ground Water Maximum Concentrations mg/kg & µg/l</u>
67-64-1	Acetone	13.80/160
78-93-3	2-Butanone (MEK, Methyl ethyl ketone, Ethyl methyl ketone)	0.024/NA
67-66-3	Chloroform (Trichloromethane)	0.010/24
75-34-3	1,1-Dichloroethane (1,1-DCA)	0.156/NA
75-35-4	1,1-Dichloroethylene (1,1-DCE, 1,1-Dichloroethene, Vinylidene chloride)	0.222/1,080
107-06-2	1,2-Dichloroethane (1,2-DCA, Ethylene dichloride)	25/NA
100-41-4	Ethyl benzene	0.300/NA
75-69-4	Freon 11 (CFC 11, Fluorotrichloromethane, Trichlorofluoromethane,Trichloromonofluoromethane)	0.156/1,718
76-13-1	Freon 113 (CFC 113, 1,1,2-Trichloro-1,2,2-Trifluoroethane)	0.880/5,240
75-09-2	Methylene chloride (Dichloromethane)	1,000/650
108-10-1	4-Methyl-2-pentanone (2-Pentanone, 4-methyl-, Hexone,Methyl isobutyl ketone)	0.011/NA
127-18-4	Tetrachloroethylene (PCE, Perchloroethylene, Ethene, tetrachloro-)	2,064/1,030
156-60-5	Trans-1,2-Dichloroethylene (1,2-Dichloroethylene, Trans acetylene dichloride,Ethene, 1,2-dichloro-)	NA/9
71-55-6	1,1,1-Trichloroethane (1,1,1-TCA, Methyl chloroform)	848/2,150
79-00-5	1,1,2-Trichloroethane (1,1,2-TCA)	0.166/NA
79-01-6	Trichloroethylene (Trichloroethene, TCE, Ethene, trichloro-)	358/350
108-88-3	Toluene (Methyl benzene, Benzene, methyl-)	0.40/NA
1330-20-7	Xylene (o-,m-, p- isomers)	0.40/NA

In addition, lead, cadmium, and mercury have been reported to be present in samples of sludge from former storage tanks at the site. Such material may have entered the subsurface soil through cracks in the concrete as a result of spills. Other hazardous substances named in the Administrative Order include ethene, ethane, isobutane, propene, 1,2-dichlorobenzene, pesticides, acids, organic peroxides, calcium carbide, hydrofluoric acid, and diethyl ether. Many of these will not be an issue for a subsurface investigation and are not addressed in this health and safety plan. These include the following:

- Ethene, ethane, isobutane and propene. These are hydrocarbon gases which have extremely low solubilities in water and would have dissipated into the atmosphere if released.

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- Calcium carbide is a solid which decomposes in the presence of water to form acetylene gas and calcium hydroxide. Like the other hydrocarbon gases the acetylene would have dissipated.

The remaining substances are presented as follows:

<u>CAS No.</u>	<u>Compound (Common Synonyms)</u>	<u>Soil/Ground Water Maximum Concentrations $\mu\text{g/kg}$ & $\mu\text{g/l}$</u>
—	Acids, n.o.s.	NA
1395-62-0	Calcium hydroxide	NA
7440-43-9	Cadmium, n.o.s.	NA
60-29-7	Diethyl ether (Ethyl ether)	NA
95-50-1	1,2-Dichlorobenzene (o-Dichlorobenzene)	NA
7664-39-3	Hydrofluoric acid	NA
7439-92-1	Lead, n.o.s.	NA
7439-97-6	Mercury, n.o.s.	NA
—	Organic peroxides, n.o.s.	NA

Notes: NA - No available information. Substance presence suspected due to former materials handling practices at the site.
n.o.s. - Not otherwise specified.

2.0 OBJECTIVE

This Health & Safety Plan (HASP) was developed to cover a variety of investigative work objectives to be performed by the England & Associates and Hargis + Associates, Inc. (England/Hargis) employees or contractors working under the direct supervision of designated England/Hargis employees. All activities will be conducted in accordance with requirements of England/Hargis Injury and Illness prevention program requirements and codes of safe practices and Unocal CERTs contractor safety handbook. Further, standard operating procedures (SOPs) and quality assurance program (QAP) are detailed within the Phase II work plan.

England/Hargis will not be responsible for the health and safety of subcontractors hired by Omega Chemical Site Organized PRP Group to perform work not supervised by England/Hargis.

2.1 Description of Site Work

In accordance with the Phase II work plan the following activities will be conducted:

- Shallow Soil Gas Survey.
- Shallow and deep soil sampling.

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- Ground water sampling.
- Location and evaluation of existing on-site well BMW-1.

Should site-specific conditions warrant (i.e., additional chemical exposure or significant change in physical site configuration) or activities beyond those described above are to be implemented, an addendum to this HASP will be prepared and implemented at the site. No additional activity will be performed until appropriately trained, qualified, and outfitted personnel are available.

2.2 Site Work Hazard Analysis

The primary health hazards associated with Phase II work plan activities are both physical and chemical in nature. Health hazards associated with the soil gas survey, deep soil sampling and ground water sampling are primarily physical in nature. Chemical hazards are anticipated to be minimal during the implementation of these field activities. The health hazards associated with hand-auger boring for shallow soil sample collection are chemical and physical in nature. During the handling of soil and ground water samples, exposure to potentially hazardous compounds through inhalation, ingestion, and dermal absorption is also concern. Physical and chemical hazards are further detailed in Sections 5.0 and 6.0 of this HASP.

3.0 PROJECT ORGANIZATION AND COORDINATION

The following persons have been designated to carry out health & safety job functions:*

Project Manager

Dennis C. England
England & Associates
Irvine, California

Task Manager

Michael A. Palmer
Hargis + Associates, Inc.
La Jolla, California

Health & Safety Director

W. Zachary Dickson
England & Associates
Irvine, California

* Or designated alternates

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Site Safety Officer

W. Zachary Dickson
England & Associates
Irvine, California

Work Party

Darren A. Azarian
Gary M. Beckerman
Bob Dadfar
W. Zachary Dickson
Michael J. Higuchi
Michael R. Lewis
Michael A. Rendina
England & Associates
Irvine, California

Greg T. Cranham
Christian A. Perkovac
Thomas W. Henderson
Steven P. Netto
Hargis + Associates, Inc.
La Jolla, California

Robert D. Coale
Gregory L. Stewart
Hargis + Associates, Inc.
Pasadena, California

* or designated alternates

The following sections outline responsibilities and levels of authority for personnel conducting field activities at the site. Project personnel will be instructed as to their site-specific responsibilities in a project meeting before field activities begin.

3.1 Project Manager

The Project Manager is responsible for ensuring that this HASP is prepared, reviewed, authorized, and implemented. The Project Manager will not initiate field activities until this HASP has been approved and assigned personnel have received the required level of

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specific health & safety instruction. The Project Manager will consult with the Health & Safety Director and Site Safety Officer (SSO) if revision of this HASP is required. The Project Manager is responsible for the overall health & safety performance and compliance with applicable regulations and is the senior level contact in the event of a site emergency.

3.2 Task Manager

The Task Manager will ensure that health & safety activities are conducted according to HASP requirements and to company policies and procedures. The Task Manager will refrain from initiating field activities until the site-specific HASP is complete. The Task Manager will notify the Project Manager if site conditions or site activities change, or if any difficulty occurs in implementing this HASP.

3.3 Health & Safety Director

The Health & Safety Director will prepare, review, and authorize this HASP and any subsequent revisions to the plan. The Health & Safety Director will assist with the implementation of the HASP and provide project support on health & safety issues. The Health & Safety Director will consult with the Project Manager and Task Manager if revision of this HASP is required. The Health & Safety Director will verify field personnel training, medical surveillance, and respirator fit-test requirements. The Health & Safety Director will advise the Project Manager and Task Manager regarding industrial hygiene concerns, interpretation and evaluation of analytical exposure data, and other safety-related issues, as needed.

3.4 Site Safety Officer

The SSO will implement this HASP in the field. The SSO authority and responsibilities include, but are not limited to, the following:

- Briefing site personnel before work begins each day regarding the contents of this HASP and authorized revisions of this HASP, including potential hazards, safe work practices, required PPE, and emergency procedures.
- Maintaining a copy of this HASP at the site.
- Ensuring that specified PPE is available and, when appropriate, worn by personnel working at the site.

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- Controlling access to the exclusion zone and/or work areas as defined.
- Establishing emergency evacuation routes and designated meeting places in advance of each work activity and communicating this information during the daily safety briefing.
- Coordinating response to emergencies at the site, directing evacuation, or summoning emergency assistance, if necessary.
- Conducting site walk-through inspections on a regular basis.
- Maintaining field documentation, including daily safety briefing attendance sheets, air monitoring data, and site walk-through inspection results.
- Notifying the Project Manager immediately regarding any health & safety problems or emergencies.
- Assigning an alternate SSO if the designated SSO will be absent.
- Halting activities when unsafe conditions or work practices exist at the site.
- Notifying the Health & Safety Director of changes in site conditions or in the scope of field activities.

3.5 Work Party

Members of the work party are required to comply with health & safety requirements presented in this HASP and in their corresponding company health & safety manuals. The responsibilities of the work party members include, but are not limited to, the following:

- Reading this HASP, their company health & safety manual, and the Unocal CERTs contractor safety handbook.
- Participating in daily safety meetings and site-specific training.
- Implementing safe work practices and good personal hygiene for hazardous waste operations.
- Maintaining PPE in good working condition.

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- Responding to site emergencies, if necessary, directing evacuation or summoning emergency assistance.
- Adhering to the provisions of the Injury and Illness Prevention Program and Hazardous Waste Operations Program.

3.6 Subcontractors

The subcontractor's management is responsible for assigning specific tasks to their employees and for ensuring that their employees are properly trained and are in compliance with applicable OSHA regulations. The subcontractor's management will provide qualified employees and allocate sufficient time, materials, and equipment to safely complete activities in accordance with this HASP.

Subcontractors shall operate under their own health & safety procedures and may use their own HASP, if such a provision is contained in a written agreement with England/Hargis. The health & safety requirements in HASPs prepared by subcontractors must be as stringent as those contained in the England/Hargis. In the event of a conflict with the England/Hargis HASP and the subcontractor's HASP, the England/Hargis HASP will take precedence. Each subcontractor shall provide a copy of their health & safety requirements for field activities to the Health & Safety Director.

Hazards not listed in this HASP but known by the subcontractor or known to be associated with a subcontractor's specialty must be identified and addressed during the daily safety briefing prior to beginning work. The SSO has the authority to remove the subcontractor and cease site operations whenever a subcontractor is operating in an unsafe manner.

4.0 GENERALIZED SITE SAFETY PROCEDURES AND REQUIREMENTS

The procedures and precautions presented below are general and apply to all England/Hargis supervised personnel regardless of the task to be performed.

- Each day prior to the performance of any field activity, the SSO will review the site-specific HASP with all involved personnel. The meeting will focus on the specific task(s) to be performed, contaminants likely to be encountered and the current physical condition of the site and work areas. Personnel will indicate an understanding of the HASP requirements and agree to accept and comply with the conditions contained herein by printing, signing, and dating the sheet attached to the document (Section 14) on a daily basis.

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- Individuals entering the work area under the supervision of England/Hargis and after conclusion of the one time daily safety meeting will be approached by the SSO. They will be directed to read the HASP and indicate understanding, acceptance, and compliance of HASP requirements by completing and signing the sheet attached to the document (Attachment A). Individual questions or concerns should be directed to the SSO.
- Individuals refusing to sign the HASP will be prohibited from entering work areas under the supervision of England/Hargis.
- England/Hargis supervised personnel must be aware of project-related traffic. Additionally, project personnel will be advised that non-England/Hargis supervised personnel and traffic may be present on-site. These individuals and associated traffic will be excluded from England/Hargis supervised work areas.
- Above-ground appurtenances may be present on-site. A complete, daily review of the site conditions is necessary prior to beginning any activity.
- To avoid vehicle collisions with above-ground structures, all drivers must walk completely around their vehicles and observe locations of all structures prior to moving any vehicle.
- Any unsafe condition or safety concern should be brought to the attention of England/Hargis's acting SSO. An SSO will be designated for each phase of the project and he/she will be identified to all personnel during the daily safety meetings. If there is a change of the SSO during the project, the change will be addressed during the daily safety meeting.
- Level D personal protective equipment (PPE) is required when performing any field work (on- or off-site) related to the project. Level D protection at a minimum consists of long pants, steel-toe boots, hard hat and safety glasses.
- Any elevated work which requires England/Hargis employees to be greater from six feet from the ground will require fall protection. England/Hargis's Health & Safety Director will approve the fall protection devices on a case by case basis. *England/Hargis will not be responsible for providing or approving fall protection relating to subcontractor activities.*

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- No England/Hargis supervised personnel will enter an excavation (deeper than four feet below the surrounding grade) at any time, further, no England/Hargis employee shall approach within two feet of the edge of any excavation greater than four feet in depth.
- No personnel may enter any confined space.
- No smoking is allowed anywhere on-site. No eating and drinking will occur within designated exclusion zones.
- All ancillary activities will be located upwind as determined by a flag or other wind-direction indicating device mounted no less than four feet above the ground surface.

5.0 SITE CHEMICAL HAZARD EVALUATION

Suspect chemical hazards and corresponding permissible exposure limits (PELs), air quality monitoring, respiratory protection action levels, and personal air monitoring are discussed in the following sections.

5.1 Suspect Substances

The purgeable organic compounds detailed in Section 1.0 have been identified in the soil and/or ground water beneath the site. In addition, the presence of metals and other hazardous substances detailed in Section 1.0 are suspected. Exposure to these substances is regulated by the Occupational Safety and Health Administration (OSHA) at both the State and Federal Levels. Where available Cal-OSHA legally PELs are presented, otherwise Fed-OSHA PELs are shown. In addition, the National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) publishes recommended exposure levels and threshold limit values (RELs and TLVs, respectively) and ceiling exposure limits. The OSHA (Cal or Fed) PELs, RELs, TLVs, and ceiling exposure limits (when available) for these substances in air are shown in the table provided below.

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Permissible and Recommended Exposure Limits (Purgeable Organic Compounds and Other Hazardous Substances)

Compound	OSHA PELs (ppmv)			NIOSH RELs (ppmv)			ACGIH TLVs (ppmv)		
	8-Hour TWA	STEL	Ceiling	10-Hour TWA	STEL	Ceiling	TWA	STEL	Ceiling
Acetone	750*	1000*	3000*	250	NA	NA	750	1000	NA
2-Butanone	200*	300*	NA	200	300	NA	200	300	NA
Cadmium	0.005 a ‡	NA	0.3 ‡, 0.6 b ‡	NA	NA	NA	NA	NA	NA
Calcium Hydroxide	15 ‡, 5 c * ‡	NA	NA	5 ‡	NA	NA	5 ‡	10 ‡	NA
Chloroform	2*	NA	50 ‡	NA	2 d	NA	10	NA	NA
Diethyl ether	400*	500 *	NA	NA	NA	NA	400	500	NA
1,2-Dichlorobenzene	25*	NA	50*	NA	NA	NA	25	50	NA
1,1-Dichloroethane	100*	NA	NA	100	NA	NA	100	NA	NA
1,1-Dichloroethylene	1*	NA	NA	NA	NA	NA	5	20	NA
1,2-Dichloroethylene	1*	200*	2*	1	2	NA	10	NA	NA
Ethylbenzene	100*	100*	125*	100	125	NA	100	125	NA
Freon 11 (CFC 11)	1000*	NA*	1000*	NA	NA	1000	NA	NA	1000
Freon 113 (CFC 113)	1000*	1250*	2000*	1000	1250	NA	1000	1250	NA
Hydrogen Fluoride	3*	6*	NA	3	6	NA	NA	NA	NA
Lead	0.05 * e	NA	NA	<0.1 ‡	NA	NA	0.15 ‡	NA	NA
Mercury	0.05 * ‡	NA	0.1 * ‡	NA	NA	NA	NA	NA	NA
Methylene chloride	50*	NA	1000 ‡	NA	NA	NA	50	200	NA
4-Methyl-2-pentanone	50*	NA	75*	50	75	NA	50	75	NA
Tetrachloroethylene (PCE)	25*	NA	300*	0.4	NA	NA	25	100	NA
Trans-1,2-Dichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane (1,1,2-TCA)	10*	10*	NA	10	NA	NA	10	NA	NA
1,1,1-Trichloroethane (1,1,1-TCA)	350*	450*	800*	NA	NA	350 f	350	450	NA

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Compound	OSHA PELs (ppmv)			NIOSH RELs (ppmv)			ACGIH TLVs (ppmv)		
	8-Hour TWA	STEL	Ceiling	10-Hour TWA	STEL	Ceiling	TWA	STEL	Ceiling
Trichloroethylene (TCE)	35*	200*	300*	25	NA	2	50	100	NA
Toluene	100	150	300	100	150	NA	50	NA	NA
Xylene	100	300	150	100	150	NA	100	150	NA

Notes: Concentrations are in parts per million by volume (ppmv) in air.

Abbreviations are: PEL = permissible exposure limit (10-hour TWA); REL = recommended exposure limit (8-hour TWA unless specifically otherwise stated); TLVs = Threshold Limit Values; (8-hour TWA) TWA = time weighted average; STEL = short term exposure limit (15-minute TWA unless specifically otherwise stated); NA = currently no available concentration for compound in question.

* PEL and STEL are promulgated by Cal-OSHA in California Code of Regulations (CCR) Title 8 § 5155.

† Though the PEL is promulgated by Cal-OSHA in respirable fraction.

CCR Title 8 § 5155, no STEL or ceiling was listed, thus the Fed-OSHA ceiling is presented (CFR 191.1000 table z-2).

‡ Concentrations are mg/m³

a refer to CCR Title 8 § 1532 & 5027.

b The first value is for fume, the second is for dust

c The first value is for total dust, the second is for

d Based on a 60-minute TWA.

e Refer to 29 CFR 1910.1025 and CCR Title 8 §5126.

f Based on 15-minute TWA.

5.2 Air Quality Monitoring - Purgeable Organic Compounds

During soil gas survey, soil sampling, ground water sampling, or any soil/subsurface intrusive activity, Volatile Organic Compound (VOC) emissions will be monitored with a Flame Ionization Detector (FID) Organic Vapor Analyzer (OVA) calibrated to a benzene standard (isobutylene). Monitoring of the breathing space and excavated material during drilling will be performed at 15-minute intervals or whenever odors are sensed. The times and concentrations encountered during monitoring will be recorded on the appropriate air quality monitoring log (Attachment D). A specification sheet for the OVA is included as Attachment E; the FID OVA operation manual will be available on-site.

Prior to initiating work activities, a perimeter survey will be conducted using the OVA in order to establish baseline VOC air concentration levels.

Based on the analysis of purgeable organic compounds and their respective concentrations documented during previous investigations, we have identified 1,1-dichloroethylene as our "target compound". Simply stated, the target compound is the compound which has the lowest permissible (PEL) or recommended exposure limits (REL) of the purgeable organic compounds previously encountered at the site. If no published Cal or Fed OSHA PEL is identified, NIOSH RELs or ACGIH TLVs are substituted. Since the FID OVA provides

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only a summary reading of all organic vapors present in the sampled gases, England/Hargis believes that a sustained reading (15-minutes) of 5 ppm (4 times less than the ACGIH STEL for 1,1-dichloroethylene) above the background levels as determined by the perimeter survey will mandate the donning of respiratory protection equipment.

Precautionary procedures which shall be taken during the field investigation are summarized in the table below:

Action Levels and Procedures

Time or Action Level	Action
Initial site arrival	Perimeter survey with FID OVA
During site investigation activities	OVA monitoring at 15-minute intervals or when odors sensed
OVA > 5 ppm over background	Stop work; Don Respirators (half-face) evaluate need for Level C Dermal Protection
OVA > 10 ppm over background	Stop work; Evaluate need for engineering controls to reduce vapor concentrations, work will not proceed until vapor concentrations are reduced or properly fitted full-face respiratory protection is provided.
OVA > 50 ppm over background	Stop work; Re-evaluate need for engineering controls to reduce vapor concentrations, work will not proceed until vapor concentrations are reduced or properly trained personnel with supplied air respiratory protection equipment are available.

5.3 Rationale for Respiratory Protection Action Levels

A concentration of 20 ppm 1,1-dichloroethylene vapor would need to be present in the breathing space for 15 minutes to approach the ACGIH STEL of 20 ppm for that compound. England/Hargis has conservatively specified a 5 ppm total organic vapor concentration over background as the action level which requires the donning of respirators. Even if the 5 ppm total organic vapor reading consisted exclusively of 1,1-dichloroethylene, employee exposure would still be limited to 5 ppm, four times less than the ACGIH STEL. To approach the Cal-OSHA PEL TWA of 1 ppm to 1,1-dichloroethylene, employees wearing the required properly fitted half-face respirators would need to be exposed to 10 ppm (over background) 1,1-dichloroethylene vapor for a continuous 8-hour period. It is highly unlikely that the total organic vapor concentrations indicated by the OVA will consist of pure 1,1-dichloroethylene, thus we believe the action levels presented above provide an adequate level of respiratory protection.

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It should be noted that the presence of calcium hydroxide (from decomposition of calcium carbide), cadmium, lead and mercury are not detectable with the OVA. Potential for exposure to these substances is limited to inhalation, ingestion, and dermal contact with contaminated air-borne dust particles. The proposed site investigative activities involve exposing site soils in specific locations by coring the concrete only to the diameter necessary to accommodate the equipment to be inserted. Only the shallow and deep soil sampling, and on-site monitoring well evaluation will involve extraction of any soil. Additionally, the natural soil moisture content will preclude dust generation thus minimizing the potential for exposure to these substances. In any event the following precautions will be observed during activities which involve extraction of soil from the subsurface:

- Soil will be placed directly into containers.
- The investigation-derived material will be lightly sprayed with water, if necessary, and will be covered to suppress dust.

These precautions will prevent soil from drying, thus reducing the potential for dust formation, and suppressing any volatile or other vapors (i.e., mercury). Care will be exercised during wetting activities not to create any run-off which may enter a boring or excavation potentially influencing the existing subsurface contaminant distribution.

5.4 Personal Air Quality Monitoring

The necessity for personal air quality monitoring equipment will be evaluated by the SSO based on breathing space air quality monitoring with the OVA and professional judgement. The presence of consistent concentrations of organic vapors approaching 5 ppm over background may indicate the need for personal air quality monitoring to evaluate individual exposure. Should personal air quality monitoring be performed, published OSHA and/or NIOSH sampling and analytical methods will be used.

6.0 PHYSICAL HAZARDS AND REQUIRED CONTROL MEASURES

Physical hazards associated with site activities include, but are not limited to, the following:

- Underground and overhead utility lines (please note: Underground Service Alert and Omega representatives will be notified of all work locations and activities prior to work commencement);
- Electrical hazards associated with equipment and local power supply;

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- Heavy equipment associated with concrete coring and cutting, soil gas survey, deep soil sampling and ground water sampling activities;
- Fire (one ABC rated-fire extinguisher must be available at all times);
- Equipment falling from overhead;
- Local area traffic; and
- Noise (hearing protection will be available).

Potential physical hazards at the site and the required control measures are listed in Attachment C.

6.1 Medical Hazards

- Chemical exposures (Section 5.1).

Vapors are irritating to the eyes, nose and throat. If a person becomes dizzy, experiences eye irritation or nausea, they will be removed from the area.

- Heat cramps, stroke and exhaustion (especially if in Level C protection).

Heat Cramps Symptoms and Signs - Severe muscle cramps (usually in the legs or abdomen), exhaustion, sometimes dizziness or periods of faintness.

Heat Stroke Symptoms and Signs - Rapid shallow breathing, weak pulse, cold and clammy skin, heavy perspiration, total body weakness, dizziness that may lead to unconsciousness.

Heat Exhaustion Symptoms and Signs - Deep breaths then shallow breathing, rapid strong pulse, then rapid weak pulse, dry hot skin, dilated pupils; loss of consciousness (possible coma); seizures or muscular twitching may be seen.

Required action for heat cramps, stroke and exhaustion

- Call for medical attention (call 911).
- Move person to nearby cool place.

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- ▶ Allow person to rest.
- ▶ Provide water for the person, let them drink under their own power (note: do not administer water to an unconsciousness person).
- ▶ If person becomes unconsciousness, cool the person by removing clothing and wrapping in wet towels and sheets, pour water over the these wrappings. Ensure emergency medical attention is on its way.

The necessity for personal heat stress monitoring will be evaluated by the SSO based on the activity to be performed and existing weather and site conditions. Additionally, the SSO will utilize employee observations and professional judgement as a basis of the need for such monitoring.

- Electrical shock and/or burns (call 911).
- Sunburn (UVa/UVb exposure - wear sunscreen).
- Insect and snake bites (call 911).

6.2 Other Hazards

Other hazards may be identified at a job-specific location. Each area will be evaluated for any site-specific hazard prior to the daily safety meeting. If a specific hazard is identified it shall be addressed during daily safety meetings.

- Be aware of the general public and their natural curiosity, ensure that no unauthorized personnel are allowed on-site at any time.

Field personnel and subcontractors shall be briefed on all identifiable site-specific hazards in daily safety meetings.

7.0 PERSONAL PROTECTIVE EQUIPMENT

We will initially be using Level D personal PPE which includes: long pants, steel-toed boots, hard hat and safety glasses. Chemical-resistant gloves and splash resistant Tyvek coveralls are required when handling ground water and soil samples or performing equipment decontamination procedures. Hearing protection will be worn when working in close proximity to drilling rigs or otherwise as necessary. Employers will provide (their

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respective employees) a complement of dermal and respiratory protective equipment (available on-site at all times). Modified Level D PPE is simply Level D protection with the addition of chemical-resistant gloves and splash resistant Tyvek coveralls. Level C PPE will consist of splash resistant Tyvek coveralls, nitrile steel-toed/shank boots, chemical-resistant gloves, hard hat, safety glasses, and half-face Air Purifying Respirators (APR) fitted with organic vapor or combination organic vapor/acid gas cartridges.

The use of Modified Level D dermal protection (Tyvek coveralls, hard hat, steel-toed/shank boots, chemical-resistant gloves) is required for personnel handling soil or ground water samples. Modified Level D dermal protection is necessary to prevent contact of contaminated material with exposed skin surfaces. Upgrade from Modified Level D PPE to Level C PPE (Modified Level D PPE with the addition of nitrile steel-toed/shank boots and Half Face Respirator) will be mandated at the discretion of the SSO, in accordance with Sections 7.1 of this HASP. Every effort will be made to reduce dermal, inhalation and ingestion exposure hazards to suspected contaminants.

England/Hargis is not responsible for providing any respiratory or dermal PPE equipment, as described herein, to subcontractor employees. Subcontractor employees working under this HASP must arrive on-site with their individual assigned half-face (and/or full-face) respiratory protective equipment, spare organic vapor or combination organic vapor/acid gas cartridges. Additionally, subcontractors will have available to their employees at all times PPE meeting Level C requirements as described above.

The SSO will be responsible for ensuring all personnel are prepared to initiate the PPE requirements outlined in this section.

7.1 Respiratory Protection Upgrade Guidelines

In the event air quality monitoring mandates the use of respiratory protection (OVA > 5 ppm) work operations will be shut down and the following will occur:

- All personnel as directed by the SSO will inspect their half-face respirators, clean as necessary, ensure proper function and don.
- All personnel shall perform both negative and positive pressure respirator fit-tests. If a respirator failure is noticed, it shall be immediately reported to the SSO and the defective respirator repaired or replaced.

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- In the event a repair or replacement cannot be made, the affected employee shall be removed from the work area until such time as a properly functioning and fitting respirator has been acquired.
- Each employee shall ensure that his/her individual respirator is equipped with organic vapor chemical cartridges or organic vapor/acid gas chemical cartridges. Respective personnel employers will ensure replacement cartridges are available (on-site).
- Once all employees have donned respiratory protection (and if necessary Level C dermal protection) and indicate to the SSO that all PPE is in place and properly functioning, work operations will resume.
- Air quality monitoring will continue as prescribed in Section 5.2.
- If it is determined that half-face respirators are not adequate for the vapor concentrations recorded (i.e., OVA ≥ 10) work shall cease and the appropriate respiratory protection obtained and/or engineering controls implemented. The SSO will ensure only appropriately trained persons wearing properly fitted respiratory protection will be utilized in continued operations.

The following shall be considered by the SSO in the event a Level C PPE upgrade occurs.

Respirators protect the wearer from inhaling toxic contaminants. Different respirator systems provide different levels of protection. Protection factors (PF) for different respiratory protection devices are presented in the table below.

Selected Respirator Protection Factors

Type of Respirator	*Protection Factor (PF)
Air Purifying - Half-Face	10x
Air Purifying - Full-Face	50x
Supplied Air Pressure Demand Full-Face (Airline)	200x
Self-Contained Breathing Apparatus (Positive Pressure)	10,000x

- * Protection factors for the respirator types presented above were assigned by OSHA (OSHA Handbook Guidelines).

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A PF is the ratio of the contaminant concentration of the outside ambient atmosphere to that of the inside concentration of the respirator face piece. Protection factors may be used to calculate the Maximum Use Limit (MUL) of a properly fit-tested respirator. England/Hargis only requires that subcontractors and employees be equipped with properly fitted half-face respirators. Thus our maximum protection factor is 10 times (10x).

Utilizing this information and having stated that 5 ppm (over background) is our initial respiratory action level based upon our target compound (i.e., the contaminant which has the lowest PEL or REL of the contaminants identified as likely to be encountered at the site), we can calculate the MUL of the half-face respirator used in an atmosphere where the PEL (8-hour TWA) is 1 ppm. The MUL for several respirators types are presented as follows:

Site-Specific MUL's by Respirator Type

Type of Respirator	*MUL (PPM) as read from the FID OVA
Air Purifying - Half-Face	10
Air Purifying - Full-Face	50
Supplied Air Pressure Demand Full-Face (Airline)	500
Self-Contained Breathing Apparatus (Positive Pressure)	10,000

Review of the above table shows that the half-face respirator has a MUL of 10 ppm (assuming a 10 ppm vapor concentration is present continuously for an 8-hour period). Thus, if total organic vapor readings exceed 10 ppm, work would cease and would not resume until a detailed evaluation of the exposure situation has been made. The evaluation may recommend use of respiratory protection with a higher PF, implementation of engineering controls to reduce or eliminate the exposure hazard, or a combination of these two procedures. If the MUL of the half-face respirator is exceeded, work will cease until a remedy for the exposure has been decided upon and implemented.

7.2 Air Purifying Respirator Limitations

All site workers are reminded that Air Purifying Respirators are subject to several important limitations.

- Be sure the respirator is properly fitted and positive and negative fit-tested. Improperly sealed and fitted respirators provide little or no protection.

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- Be sure that the appropriate chemical cartridge is installed within the respirator. Improperly installed or chosen chemical cartridges will provide inadequate or no protection.
- Chemical breakthrough of a cartridge can occur. The breakthrough rate varies by individual breathing rate, chemical concentration in the atmosphere and a multitude of other environmental and individual factors. All personnel must replace their chemical cartridge when breakthrough is suspected. *At a minimum the chemical cartridge will be replaced each day during work which requires respirator use.*
- APRs provide no protection in oxygen deficient atmospheres.

8.0 DESIGNATED WORK AREAS

To control unauthorized access of the public or workers (non-England/Hargis supervised) to any England/Hargis supervised work area, an exclusion zone will be set up to surround the England/Hargis supervised activities. The exclusion zone will consist of temporary barriers and absolutely no unauthorized personnel will be allowed within the exclusion zone. PPE as designated in Section 7.0 will be required and no eating, drinking, or smoking shall be allowed. Exclusion zones will be maintained and relocated, as necessary.

The site will be secured each day by locking the entrance gate thus ensuring no unauthorized access. Additionally, each work area will be cleaned as detailed in Section 9.0.

9.0 DECONTAMINATION PROCEDURES

Decontamination procedures will be performed within the exclusion zone using a portable decontamination station. The portable decontamination station will consist of two sets of three decontamination buckets and associated ancillary equipment (brushes, etc.). One bucket set is for washing sampling or other equipment and one is for personnel decontamination. These stations will be maintained within the exclusion zone. If necessary, a self-contained steam cleaning unit may be provided. Appropriate receptacles for disposal of miscellaneous equipment, PPE, and decontamination water and rinsate will be provided. Decontamination procedures are presented below:

9.1 Personnel

- Chemical-resistant gloves shall be worn when handling soil or ground water.

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- Personnel leaving the exclusion zone will wash, rinse, and remove gloves and wash hands and face in clean water using soap.
- If wearing Level C dermal and respiratory protection, prior to exiting the exclusion zone personnel will wash, rinse, and remove gloves and boots. Remove Tyvek and place in plastic trash bag. Wash hands and face in clean water using soap.
- Respirators will be cleaned and sanitized prior to each use. England/Hargis will provide a sanitizing agent such as MSA Cleaner-Sanitizer II for this purpose.

9.2 Equipment

- Equipment decontamination will be performed as detailed in the SOPs.

9.3 Other Personnel Protective Procedures

- There will be no eating or drinking within the exclusion zone.
- Smoking is not allowed anywhere on-site.
- Personnel are requested to drink plenty of fluids, a drinking station will be provided and maintained outside the exclusion zone.
- Facial hair which obstructs the proper fit of respiratory protection is not allowed.
- Chemical-resistant gloves will be worn during the performance of any sampling (soil, water, or vapor) procedure.

10.0 DISPOSAL PROCEDURES

Soil cuttings or other solids will be placed in DOT-rated 17H 55-gallon liquid tight-drums or stored in covered soil storage bins. Purge and decontamination or other fluids will be placed in DOT-rated 17H 55-gallon liquid tight-drums or collected directly into vacuum vehicles. All containers will be appropriately labeled *each day* prior to leaving the site. Each work location will be thoroughly cleaned at the end of each work day. All garbage, debris, and soil will be placed in sealed, appropriately labeled containers each day. Equipment remaining on-site overnight will be stored in a neat, safe, and secure fashion.

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11.0 SITE SECURITY AND SITE CONTROL

The Omega site is a gated, locked facility surrounded by an 8-foot high security fence with a razor wire top. Entrance to the site will be controlled by the gate on the fence. The gate will be opened for entrance and egress of site workers and will remain closed at all other times. The gate will be locked after the last person leaves site at the end of each day.

All work at the site is expected to be conducted during the daylight hours between 7:00 a.m. and 7:00 p.m. with the maximum work day length not anticipated to exceed 12 hours.

12.0 TRAINING AND MEDICAL SURVEILLANCE REQUIREMENTS

All site personnel, including subcontractors, will have successfully completed a 40-hour, and annual 8-hour refresher course in health & safety for hazardous waste site operations in accordance with 29 CFR 1910.120 and will have been determined to be physically fit and capable of wearing respiratory protection by a medical doctor on an annual basis before being permitted to work at the site. The corporate Health & Safety Director will be responsible for personnel document verification and follow up activities related to accident loss reports submitted by the Project Manager.

The Project Manager will be responsible for the technical aspects of the project and to assure that project health & safety requirements are implemented.

The SSO will have undergone the additional, one-time OSHA 8-hour supervisory training for hazardous waste sites and is responsible for conducting daily safety meetings for all site personnel (subcontractors and regulatory personnel included) addressing hazard assessment, personnel protective equipment, and implementation of the directives presented in the HASP.

Field personnel, including all subcontract personnel and regulatory agents, are responsible for understanding and complying with the HASP. Field personnel will be required to acknowledge and sign and date a copy of the HASP after each daily safety briefing.

Personnel with special personal health conditions which prohibit compliance with any or all parts of the HASP will not be allowed within England/Hargis supervised work areas.

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13.0 EMERGENCY RESPONSE PLAN

Potential site emergencies include, but are not limited to, fire, earthquake, heat stroke, and other physical or chemical injuries that require immediate medical attention. The SSO or designated alternate will respond to on-site emergencies, direct site evacuation, and summon emergency assistance as necessary.

13.1 Pre-emergency Planning

Emergency contacts and telephone numbers, and the hospital route will be readily available at the site. A place of refuge and/or emergency meeting place will be announced by the SSO at the daily safety meeting. The SSO will designate the upwind meeting place, following an evacuation to a site emergency, field personnel will meet at the designated meeting place for a head count. Plans for a safe and effective response to potential emergencies will be developed by the SSO before daily field activities begin. Pre-emergency planning includes reviewing the emergency response plan with site personnel and inspection of emergency response equipment and supplies.

13.2 Personnel Roles, Lines of Authority, and Communication

In the event of an emergency, the SSO must be notified. The SSO is responsible for responding to the immediate emergency situation. The initial response includes, but is not limited to, notifying on-site personnel, evacuating the area, and notifying the appropriate emergency response authorities, as needed. The SSO shall contact the Project Manager and Field Task Manager. The Project Manager shall notify the Health & Safety Director that an emergency situation has occurred. All field personnel present at the site have the authority and responsibility for reporting a site emergency.

13.3 Emergency Recognition and Prevention

Emergencies will be minimized through proper supervision, employee training, and site management. The impact of the emergency situation will be minimized to the extent possible.

13.4 Emergency Signals

In the unlikely event that an emergency situation occurs, all work activities at the site will cease. Notification of an emergency situation will be signaled by sounding an on-site vehicle

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horn. If verbal communication is difficult, impractical or impossible the following hand/body emergency communication signals will be used:

<u>Signal</u>	<u>Meaning</u>
Hands Clutching Throat:	Can't Breath/Choking
Hands on Top of Head:	Need Assistance
Thumbs Up:	OK/I'm all right/I understand
Grip another person's wrist or both hands on another person's wrist:	Leave area immediately

If an emergency occurs in the exclusion zone and personnel are wearing PPE greater than Level D, PPE will be doffed prior to exiting the exclusion zone and personal decontamination procedures as described in Section 8 implemented. If the emergency is life threatening, decontamination may not be appropriate.

13.5 Safe Distances and Places of Refuge

In an emergency, field personnel should stay calm and summon help as needed. Wind socks or ribbons will be visible to field personnel in the work area to indicate wind conditions. If evacuation is necessary, field personnel should leave the work area immediately by the shortest route possible, and assemble at a predetermined location upwind of the work area activities. The assembly point will be determined by the SSO in conjunction with the on-site subcontractors in advance of each work activity. The assembly location depends on work area and wind direction, and may vary from day to day. This assembly point will be at a safe distance from the emergency situation. In the event that refuge must be taken, the SSO will direct personnel to that location. Field personnel must not re-enter the work area until the SSO has instructed that it is safe to do so.

13.6 Emergency Site Security and Control

In the event of an emergency, the SSO or designated alternate will control access and traffic to the work zones. The SSO is responsible for maintaining emergency site security.

13.7 Site Evacuation Route

A map showing the site emergency evacuation route will be provided and/or posted prior to beginning field work. If an emergency requires evacuation, the SSO will alert field personnel by sounding a vehicle horn or other alarm. Field personnel will immediately

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leave the work area through the predetermined evacuation route. The SSO will conduct a head count of evacuated field personnel to ensure that everyone is accounted for.

When working in areas such as parking lots or between buildings, equipment and vehicles must be located to provide both sufficient room for safe working practices and several escape routes in case an emergency requires evacuation.

13.8 Contingency Procedures

Life-threatening incidents, such as fire, explosion, or a hazardous material spill or release, may warrant evacuation. All persons should be removed from the affected area immediately in accordance with the site emergency evacuation route. Medical assistance should be obtained if necessary. All on-site personnel should immediately be notified of the emergency situation. The local fire department will be contacted to assist in a fire or spill.

13.8.1 Fire

All field personnel are authorized to use a fire extinguisher if the fire is small and does not endanger their health or life, is caused only by project operations, and is within their ability to control. Smoking, open flames, and spark-producing equipment are prohibited in areas where flammable liquids or gases are used or may be generated. Open flames are prohibited within 75 feet of points where flammable liquids or gases may accumulate. Only Factory Mutual/Underwriters Laboratories-approved containers will be used for handling flammable combustible liquids in quantities greater than 1 gallon. An electrical bond must be maintained between containers when flammable liquids are being transferred, and equipment must be grounded. Any rags or other waste material soaked with combustible or flammable liquid must be disposed of in a closed container. Heavy equipment and vehicles will each be equipped with a fire extinguisher.

13.8.2 Materials Spill

All field personnel are authorized to contain hazardous material spills by immediate diking and clean-up only if the spill was created by project operations. Equipment and work areas will be maintained in clean, proper working order. Caution will be exercised during field activities to prevent spilling materials generated during field activities. In the event that project-generated materials are spilled, response actions must be initiated by first contacting the SSO. Proper PPE and spill clean-up materials will be available on-site.

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Hazardous materials spills will be contained by immediate diking using spill clean-up materials present on-site. Containment of spills by field personnel during field operations is limited to those materials generated during field work performed by project personnel, including soil sampling. Project personnel are not authorized nor are they trained for hazardous materials response to contain spills of other materials on-site. Field personnel are instructed to call the client contact and/or emergency response number if they witness a spill of hazardous materials other than that generated during project field activities.

13.8.3 Earthquake

Any personnel inside a building during an earthquake should remain indoors and take cover under a desk, in a doorway, or against an inside wall. Personnel should stay away from windows and light fixtures. If outdoors, personnel should move to an open, clear area away from buildings, tanks, heavy equipment, above-ground piping, and power lines.

13.9 Emergency Decontamination Procedures

In the event of chemical exposure requiring decontamination, personnel should remove contaminated clothing, rinse skin with large amounts of water and seek medical attention.

13.10 Emergency Medical Treatment and First Aid

In the event of personal injury or illness, professional medical assistance should be summoned as appropriate. An occupational physician retained by Hargis + Associates, Inc. is available through a 24-hour pager number for consultation in the event of chemical exposure or personal injury of a Hargis + Associates, Inc. employee.

First-aid equipment and supplies, will be accessible at all times. A portable eye wash station capable of flushing the eyes for fifteen minutes will be available in the immediate vicinity. Professional ambulance services will be used to provide prompt medical attention and transportation. A portable fire extinguisher will be available at all times.

13.11 Emergency Alerting and Notification Procedures

Should an accident occur in the field, the nearest appropriate facility (i.e., medical facility, fire department, police department) will be notified immediately. Due to the close proximity of the hospital (less than 1 mile from the site), England/Hargis will rely on professional medical service providers for response to medical emergencies. Though

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individuals with first aid/CPR training may be present on-site the presence of such individuals is not required by this HASP. General procedures are as follows:

- In the event of fire or other emergency dial 911.
- Get medical attention for the injured person immediately.
- Notify the SSO, Project Manager, Task Manager, and the injured person's personnel office.
- Prepare an incident report. The Project Manager is responsible for its completion and submittal to the Health & Safety Director and the Unocal Corporate personnel office within 24 hours.
- The SSO will assign duties and coordinate with emergency response personnel as required.

It is anticipated that the only possibility of material spill will involve liquid or soil derived or generated during site activities (i.e., soil and/or purge water). However to ensure appropriate legal reporting requirements relating to a reportable quantity (RQ) material release the National Response Center (NRC) should be contacted. Additional emergency assistance for handling material releases can be obtained by calling CHEMTREC. The phone numbers are listed below.

National Response Center (NRC) 1-800-424-8802
CHEMTREC 1-800-424-9300

13.12 Route to Hospital

The location of the nearest medical facility, including the address and phone numbers are presented below. A hospital location map is attached.

- Nearest Hospital **Presbyterian Inter-Community Hospital**
 12401 East Washington Boulevard
 Whittier, California
 Switch Board (310) 698-0811

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To reach the hospital, exit the site south (right) onto Whittier Boulevard, travel to Washington Boulevard and turn right. The hospital is located on the right (north) hand side of Washington Boulevard.

13.13 Emergency Contacts List

Company	Name	Number	Fax
ENGLAND & ASSOCIATES 15375 Barranca Parkway, Suite F-106 Irvine, California 92718	Dennis C. England	O(714) 453-8085 P(714) 733-6360	(714) 453-0733
	Michael A. Rendina	O(714) 453-8085 P(714) 733-6653	
HARGIS + ASSOCIATES 2223 Avenida De la Playa, Suite 300 La Jolla, California 92037	David R. Hargis	(619) 454-0165	(619) 454-5839
	Michael A. Palmer. (Pam Battles: Secretary)	O(619) 454-0165 P(800) 946-4646 Pin # 1102141 C(619) 985-7451 H(619) 595-0745	
HARGIS + ASSOCIATES 225 South Lake Avenue, Suite 403 Pasadena, California 91101-3010	Robert D. Coale	(818) 583-8121	(818) 583-8997
HARGIS + ASSOCIATES (For Hargis Employee Injuries Only)	Dr. M. Joseph Fedoruk Company Occupational Physician	(714) 550-7211 24 Hrs.	(714) 550-7215
UNOCAL CORPORATION 1201 West 5th Street Los Angeles, California 90017-1461	Dr. Ian A. Webster Project Coordinator	O(213) 977-6382 P(800) 759-7243 Pin #45934	(213) 977-5863
EPA Federal On-Scene Coordinator (FOSC)	Kay Lawrence	Primary (415) 744-2289 Alt (emergencies) (415) 744-2000	(415) 744-1916

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14.0 ACKNOWLEDGEMENT AND UNDERSTANDING OF PLAN

This health & safety plan was prepared by the undersigned, having successfully completed OSHA standard 29 CFR 1910.120 40-hour hazardous materials health & safety training.

Health & Safety Director:

W. Zachary Dickson

Site Health & Safety Officer:

W. Zachary Dickson

Project Manager:

Dennis C. England

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I UNDERSTAND AND AGREE TO THE ABOVE PLAN

Name & Company

Date

Contractors:

_____	_____
_____	_____
_____	_____
_____	_____

Geologist/Field
Technicians:

_____	_____
_____	_____
_____	_____
_____	_____

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Attachments

ATTACHMENT A

Daily Field Safety Briefing Attendance Sheet

Date: _____
Location: _____
Presented by: _____
Topics covered: _____

A. GENERAL INTRODUCTION

1. Location of site Health and Safety Plan (HASP) and ensure everyone has read the site HASP.
2. Primary hazards and controls (chemical, physical, and biological).
3. Sanitation and decontamination (potable water, non-potable water, toilet, sink, shower).
4. General Site Rules.
5. Emergency Response Plan (location where emergency telephone numbers and hospital route posted, shower, first aid kit, fire extinguisher, alarm system, evacuation, meeting place, contingencies, upwind).
6. Establish buddy system, if necessary.

B. SPECIFIC PRECAUTIONS FOR DAY'S ACTIVITIES

C. ON-SITE ORGANIZATION AND COORDINATION

D. OTHER TOPICS: _____

ATTENDEE LIST

NAME (print)	COMPANY	SIGNATURE
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

HARGIS + ASSOCIATES, INC.

ENGLAND & ASSOCIATES



Presbyterian Inter-Community Hospital
12401 East Washington Boulevard
Whittier, California
(310) 698-0811

SITE

WHITTIER

NOT TO SCALE

DIRECTIONS TO THE HOSPITAL

To reach the hospital, exit the site south (right) onto Whittier Boulevard, travel to Washington Boulevard and turn right. The hospital is located on the right (north) side of Washington Boulevard.

Attachment B
HOSPITAL LOCATION MAP

OMEGA CHEMICAL
WHITTIER, CALIFORNIA

PREPARED FOR
OPOG

ENGLAND & ASSOCIATES

HARGIS+ASSOCIATES, INC.

ATTACHMENT C

Potential Physical Hazards and Required Control Measures

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Objects striking head	Hard hats will be worn during construction, maintenance, and heavy equipment operations. When there is a potential for overhead hazards, hard hats will be worn.
Flying particulates or objects	Safety glasses and/or face shields will be worn during construction, maintenance, and sampling activities. When there is a potential for flying projectiles, such as hand tools, safety glasses will be worn.
Foot hazards	Steel-toed boots will be worn at all times while on-site.
Heat afflictions	Observe work/rest cycles for measured temperature conditions and follow heat stress prevention measures.
Mechanical systems and moving equipment	All cleaning, repairing, and servicing of machines and equipment will be conducted in accordance with Title 8, California Code of Regulations (CCR), Sections 3314 and 3328 and applicable Federal Occupational Safety and Health Administration (OSHA) regulations. Machine guards will be used where appropriate to provide maximum protection for field employees. Access to areas where moving machines and machines with moving parts are located will be controlled and limited to those individuals experienced with those machines or who have received proper safety instruction with respect to the machinery. All major installations or major repair to mechanical systems will be conducted only by a qualified mechanical contractor. Only qualified personnel will make minor adjustments to those systems with prior approval by the Project Manager. Copies of the applicable operation and maintenance manual and manufacturer's operations manuals will be available on-site at all times.
	Loose, ragged, or poorly fitted clothing, dangling jewelry, or rings will not be worn when working around equipment or machinery. Any of these items could become snagged in moving equipment and result in serious injury. All long hair will be contained to prevent it from getting caught in moving equipment.
	Air compressors and pumps are started automatically under some conditions. This equipment will be electrically disconnected and locked out before service or repair.
Equipment failure	All equipment will be inspected and tested before use, and will be maintained in accordance with manufacturer's specifications. Malfunctioning equipment will be tagged and locked until repairs are made.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Fire	Open fires and smoking are prohibited. Instrumentation used in hazardous areas will be rated intrinsically safe for Class I atmospheres. Inspect fire extinguishers daily before work begins.
Noise	Hearing protection will be used as necessary. In general, if a normal conversation cannot be heard, hearing protection is required. If deemed appropriate, the SSO may perform noise level or audio dosimetry testing to determine if noise levels are excessive. Equipment should be maintained so that noise levels are minimized. Avoid high noise levels whenever possible. When high noise levels are unavoidable, such as during heavy equipment operations, wear hearing protection. Take special care when wearing hearing protection around drill rigs and other equipment and in high traffic areas as the ability to verbally communicate a warning is minimized. Maintain visual contact with co-workers.
Thermal burns	Use personal protective equipment (PPE) to protect skin from heated equipment surfaces on equipment. Label hot surfaces that can cause thermal burns.
Construction debris	Miscellaneous obstacles may be present at various site locations. Field employees will be aware of objects underfoot, particularly when walking in grassy areas.
Slips, trips, falls	Minimize the potential for slips, trips, and falls by providing clear footing, clearly identifying any tripping hazards, and maintaining awareness of uneven terrain.
Excavation	Excavation activities are not anticipated for this site. Do not enter into any excavation more than 4 feet deep without proper shoring or sloping in accordance with CAL/OSHA Regulations S-358, 5192, 341, 344.70, 1523, 1540 through 1543, and 5156, and applicable federal OSHA regulations. Before entering an excavation, notify all equipment operators of intent to do so. Do not enter any excavation without an observer; at least one person must remain at the top of the excavation and maintain visual contact with the person in the excavation. The observer will watch for potentially unsafe conditions and be available to go for help if needed. Do not stand adjacent to any unshored or unsloped excavation.
Confined space entry	Confined space operations are not anticipated for this site. Confined space operations require the use of the Confined Space Entry Permit and Observer Checklist. Standard operating procedures for confined space work shall be strictly adhered to.
Underground utility lines	Contact an underground service alert service before excavating to avoid utility line contact.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Electrical	Electric work is not anticipated for this site. Any electrical work on 120-volt or greater power circuits will be performed by a licensed electrical contractor. Qualified personnel may perform testing of power circuits and modifications to control circuits with prior approval from the Project Manager. Only personnel familiar with the particular system may work on that system. All electrical work will be conducted in accordance with Title 8, CCR, Subchapter 5, Electrical Safety Orders and applicable OSHA regulations.
Heavy equipment operation	Seat belts will be provided on all equipment and employees using such equipment will be instructed in their use. All equipment will be equipped with the proper roll-over protection. The rated capacity of the equipment will be readily visible. Only individuals trained in safe operation and authorized by the employer may operate such equipment (Title 8, CCR, Sections 3653, 3660, and 3664). All subcontractors who operate heavy equipment will provide proof of current applicable certification/license.
Excavating equipment	Excavation work is not anticipated for this site. Do not approach excavating equipment or the excavation without first notifying the equipment operator of intent to do so. Make direct eye contact with the operator. Do not assume the operator sees you. Any person entering the excavating equipment work area will wear an orange safety vest. Do not stand alongside, behind, or in the operating area of any operating excavating equipment. Be aware of the tail and boom swing-radius of trackhoes, cranes, and other center pivoting equipment. Also be aware of pinch points on articulated equipment such as front-end loaders.
Vehicles	All vehicles will be parked away from operating excavating equipment areas unless necessary to load or unload equipment or samples. No vehicle will enter any operating excavating equipment area without first notifying all excavating equipment operators. Any vehicles in the operating excavating equipment area will have a suitable warning flag or strobe attached to the vehicle.
Overhead utility lines	Maintain a minimum of 10 feet of clearance between any field equipment and high voltage lines; lines carrying more than 50,000 volts require additional clearance; electrical arc hazard is increased during high humidity or rainy conditions.
Manual lifting	During any manual material handling tasks, personnel are to lift with the force of the load suspended on their legs and not their backs. Several persons may be needed to lift or handle heavy equipment.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Weather conditions	Severe thunderstorms, lightning, and local flooding may occur during the rainy season. In case of severe weather, halt all operations and move indoors or into the cab of a truck as soon as possible. Avoid ravines and small arroyos due to the possibility of flooding during heavy rainfall. If there is lightning activity in the vicinity, the Field Task Manager at the site will decide when to halt site activities. A rule of thumb is to halt site activities if ground-to-air lightning is present within 1 mile of the site. To gauge the proximity of lightning, count the number of seconds between the lightning strike and the sound of thunder. A span of approximately 7 seconds indicates a 1-mile distance.
Compressed gas cylinders	Such vessels will be secured and used with the manufacturer's recommended valves and fittings. Unused cylinders will be secured and capped. All cylinders will be identified or labeled.
Vehicle traffic	When conducting field activities in roads, streets, and parking lots, mark the area with safety cones, wear orange traffic vests, and turn on the vehicle's emergency flashers. Safety cones should taper gradually and allow cars to change lanes or merge easily. Safety cones should extend past the work area. One field employee should act as an observer and watch the traffic and act as a buddy to the other field employee.
Shoring of Excavations	Shoring of excavations is not anticipated for this site. A H&S permit from CAL/OSHA is required when personnel enter an excavation or trench five feet deep or greater. Only a competent and adequately trained inspector will perform excavation and trenching activities. All excavation, trenching and shoring activities will be performed according to Standard Operating Procedures provided (by Contractor).

AIR QUALITY MONITORING LOG

Project Number: _____

Sheet _____ of _____

Project Name: _____

Date: _____

Monitoring Technician: _____

Project Location: _____

Monitoring Criteria: _____

Monitoring Instrument(s): _____

CALIBRATION LOG:

Date/Method: _____

Calibration Gas: _____

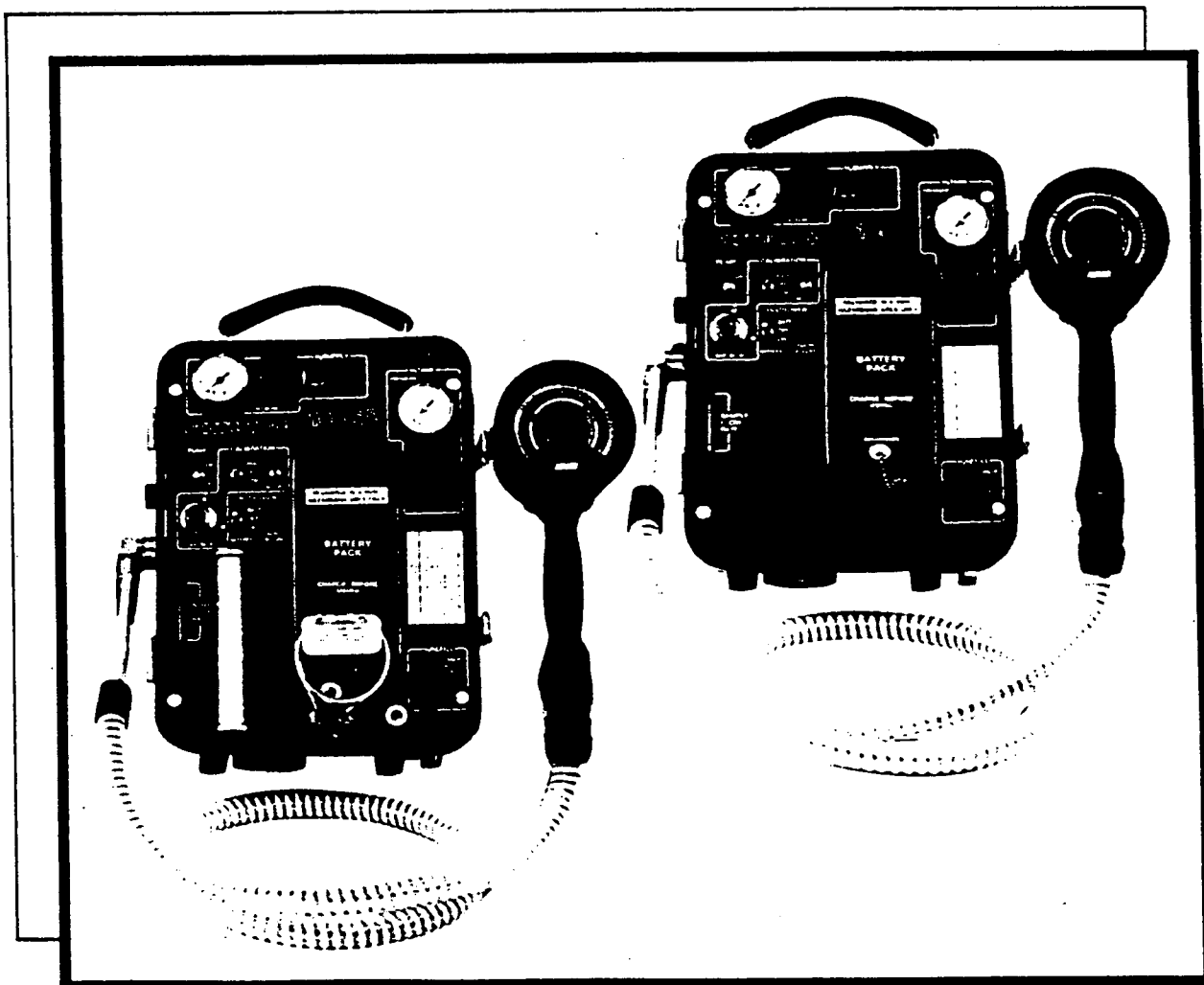
Instrument Response: _____

[illegible]

ENGLAND &
ASSOCIATES

Instruction Book 3433

CENTURY® OVA 108
Portable Organic Vapor Analyzer



FOXBORO®
A SIEBE COMPANY

INTRODUCTION

The Model OVA 108 CENTURY Organic Vapor Analyzer (OVA 108) is a portable instrument, and is offered in two configurations. These are:

1. Basic Flame Ionization Detector (FID) for Monitoring Total Hydrocarbons.
2. Gas Chromatograph (GC) Supplied with Two Columns.

A battery charger can be ordered for either 120 V ac, 60 Hz or for 220 V ac, 50 Hz operation.

Electrical Classifications are as Follows:

- FM certified for use in Class I, Groups A, B, C, and D, Division 1 hazardous locations.
- BASEEFA certified intrinsically safe, Ex ib, for IIC, Zone 1, Temperature Class T4. BASEEFA No. 76002/B Standard SFA 3007.

Accessories Available for the OVA 108 are:

- Strip Chart Recorder: The recorder is available with either FM or BASEEFA certification.
- Activated Charcoal Filter Adapter: The adapter is used for zeroing the analyzer in a contaminated environment. It is also used with desiccant as a moisture trap.
- Sample Dilutor Assembly for 10:1, 25:1, or 50:1 Sample Dilution.
- Septum Adapter for Direct, On-Line Injection with the GC.
- Portable Isothermal Pack (PIP) for Temperature Control of GC Columns.

The OVA 108 is a sensitive instrument designed to measure trace quantities of organic vapors in air. It is essentially a flame ionization detector such as is utilized in laboratory gas chromatographs and has similar analytical capabilities. The flame ionization detector is an almost universal detector for organic compounds with the sensitivity to measure in the parts per million range (V/V) in the presence of atmospheric moisture, nitrogen oxides, carbon monoxide, and carbon dioxide.

The instrument has broad application since it has a chemically resistant air sampling system, and can be readily calibrated to measure almost all organic vapors. Designed for use as a portable survey instrument, it can also be readily adapted to fixed remote monitoring or mobile installations. It is ideal for the determination of many organic air pollutants and for monitoring the air in potentially contaminated areas.

The OVA 108 is certified by Factory Mutual (FM) for use in Class I, Groups A, B, C, and D, Division 1 hazardous locations. Similar foreign certifications have been obtained, including BASEEFA. This requirement is especially significant in industries where volatile flammable petroleum or chemical products are manufactured or used. Such instruments must be incapable, under normal or abnormal conditions, of causing ignition of hazardous mixtures in the air. In order to maintain the certified safety, it is important that the precautions outlined in this manual be practiced and that no modifications be made to these instruments.

It is recommended that this entire document be read before operating the instrument. It is essential that all portions relating to safety of operation and maintenance be thoroughly understood.

REFERENCE DOCUMENTS

MI 611-170 Operation of Dilutor Kit
MI 611-105 Operation of Portable Isothermal Pack
MI 611-144 Replacement Kit to Rebuild High and Low Pressure Regulators
MI 611-172 Calibration Kit Operation and Procedures
MI 611-178 Replacement Kit to Replace Readout Assembly Harness and Handle
PL 611-136 OVA 108 Parts List

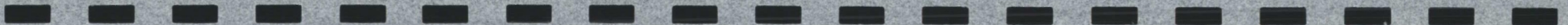
GENERAL DESCRIPTION

The OVA 108 (Figure 1) Analyzer is designed to detect and measure hazardous organic vapors and gases. It has broad application since it has a chemically resistant sampling system, and can be calibrated to almost all organic vapors. It can provide accurate indication of gas concentration from 1 to 10 000 ppm or 1 percent. While designed as a lightweight portable instrument, it can be permanently installed to monitor a fixed point.

The instrument utilizes the principle of hydrogen flame ionization for detection and measurement of organic vapors. The instrument measures organic vapor concentration by producing a response to an unknown sample, which can be related to a gas of known composition to which the instrument has previously been calibrated. During normal survey mode operation, a continuous sample is drawn into the probe and transmitted to the detector chamber by an internal pump.

The sample stream is metered and passed through particle filters before reaching the detector chamber. Inside the detector chamber, the sample is exposed to a hydrogen flame which ionizes the organic vapors. When most organic vapors burn, they leave positively charged carbon-containing ions. An electric field drives the ions to a collecting electrode. As the positive ions are collected, a current corresponding to the collection rate is generated. This current is measured with a preamplifier which has an output signal proportional to the logarithm of the ionization current. A signal conditioning amplifier is used to amplify the signal from the preamp and to condition it for subsequent meter or external recorder display. The display is an integral part of the Readout Assembly and has 270° scale deflection.

Appendix C



**STANDARD OPERATING PROCEDURES
FOR FIELD ACTIVITIES**

Omega Chemical Site
12504 and 12512 East Whittier Boulevard
Whittier, California
Project No. 399-A

PREPARED FOR

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October 27, 1995

STANDARD OPERATING PROCEDURES (SOPs)
FOR FIELD ACTIVITIES
Omega Chemical Site PRP Organized Group
Whittier, California

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1.0 SHALLOW SOIL GAS SURVEY

1.1 Objective

Shallow soil gas sampling will be used as a reconnaissance tool to characterize potential sources of shallow vadose zone contamination, and to select soil sampling locations. Shallow soil gas samples will be collected by pushing or driving steel sampling probes into the ground and evacuating them with a vacuum pump. Sample collection and analysis will be performed in accordance with the guidelines established by the Los Angeles Regional Water Quality Control Board (RWQCB) in its *Requirements for Active Soil Gas Investigation* (March 1994) (Appendix E).

1.2 Preparation

Prior to commencing a sampling event, the following will be determined and discussed with field personnel:

- Objectives of the sampling event.
- Location and number of sampling locations.
- Schedule of analyses to be performed.
- Health and safety procedures for all personnel.
- Appropriate permits, utility clearances, insurance requirements, contractual requirements, and site access procedures, if applicable.

1.3 Procedures

The following procedures will be performed for the collection of soil gas samples:

- Review objectives and exact location of areas to be sampled with subcontractor.
- Verify sample identification system with mobile laboratory chemist.
- Ensure all equipment blanks are negative prior to sampling.
- Note weather conditions in a field notebook.
- Where necessary, cut concrete immediately prior to sampling.

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- Install a disposable sampling point of the bottom of the soil gas sampling probe. Push the probe into the ground using an hydraulic pushing mechanism. This requires a 2-inch diameter access hole through any concrete surface.
- If the hydraulic mechanism cannot push the probe into the ground a sufficient depth for sampling, an hydraulic hammer will be used to advance the probe into the ground.
- Install a stainless steel adaptor on the top of the soil gas probe.
- Attach a vacuum pump onto the adaptor with silicone rubber tubing.
- Conduct a site-specific purge volume vs. contaminant concentration test in order to minimize purge volumes and obtain representative samples.
- Purge soil gas for the optimum period determined from the purge volume vs. concentration test.
- Collect soil gas sample using procedures in accordance with RWQCB *Requirements*.
- Analyze samples for the 23 target compounds specified by the *Requirements*. Additional analytes may be added, depending upon site-specific conditions. Attain a maximum detection limit of 1 $\mu\text{g}/\ell$.
- Where appropriate, resume hydraulic pushing to next sampling depth, and repeat sampling procedure.
- Pull out and decontaminate the steel sampling rods.
- Abandon the sampling hole by filling from the bottom with cement or bentonite grout, using a tremie pipe.
- All analytical quality control procedures, including calibration, preparation of blanks, record keeping, and reporting, shall be conducted in accordance with the requirements outlined in the RWQCB *Requirements for Active Soil Gas Investigation*, (March 1994).

STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES

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Whittier, California

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1.4 Sample Containers. Preservation and Transmittal

Collection of soil gas samples will be through glass syringe, with immediate direct injection. Sample containers will not be used.

Split soil gas samples may be collected during soil gas sampling activities for analysis by another laboratory. If obtained, split samples will be collected in stainless steel bottles.

All stainless steel bottles will be inspected to ensure their integrity prior to sample collection. The stainless steel valves will not be opened until just prior to their application to the flow stream. Immediately after a sample is collected, the valves will be closed and secured with tape. The sample bottle will then be labeled in accordance with the Quality Assurance Program (QAP).

1.5 Equipment Decontamination and Disposal Procedures

The following equipment decontamination and disposal procedures will be used during and after soil gas sampling activities:

- ▶ Steam clean probes and points prior to each sampling day
- ▶ Remove the adaptor and store with equipment to be cleaned
- ▶ Using the hydraulic mechanism, pull the used probe to remove it from the ground.
- ▶ Store the used probe in a tube designated for used probe storage.

1.6 Documentation

Documentation will include records of sampling events noted in the field notebook, sample identification forms, and chains-of-custody for soil gas samples. Sample identification will be performed in accordance with the QAP.

The field notebook will be the responsibility of the field team leader. All entries will be signed and dated, and the field notebook will be kept as a permanent record. The following information will be recorded in the field notebook each time a soil gas sample is collected;

- ▶ sample location/identifier
- ▶ depth at which sample was collected
- ▶ date and time sample was collected
- ▶ any other pertinent information and observations, including any difficulties in sampling or unusual occurrences.

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Electronic data from this activity will be archived and made available to the EPA at their request.

1.7 Quality Assurance

QA procedures utilized by the soil gas specialty contractor during soil gas sampling are contained in Appendix D of this workplan. In addition, the following quality assurance/quality control (QA/QC) procedures will be performed during soil gas sample collection:

- Check and purge sampling syringes for contamination prior to sampling by injecting nitrogen carrier gas into the GC.
- Sample and analyze ambient air prior to analysis of unknown samples.
- Analyze a duplicate sample for every 10 soil gas samples.
- Analyze a system blank prior to sampling and after every 10 soil gas samples. A randomly selected syringe will be analyzed to determine whether interferences from syringes are present. If interference is found at unacceptable levels, a second syringe will be analyzed to determine whether the interference is due to the syringe or the analytical system.
- Analyze the aqueous standard at the start of each day and after every fifth sample to check instrument performance.
- Collect split soil gas samples from selected locations and send to an independent check laboratory for analysis. One split sample will be collected for independent analysis approximately every 10 samples.

2.0 SHALLOW SOIL SAMPLING

2.1 General Statement

Sampling of shallow soil, concrete, and asphalt will be conducted to determine the presence or distribution of surface or shallow subsurface contamination.

2.2 Sampling Equipment

Surface concrete and asphalt samples will be collected using clean, decontaminated hammers, chisels, and stainless steel trowels. Shallow soil samples will be collected using conventional

STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES

hand augering techniques. A 2-inch diameter soil sampler lined with one 6-inch long brass or stainless steel sampling tube will be used to collect soil samples from hand-augered borings. The soil sampler will be driven ahead of the hand-augered portion of the borehole to collect soil samples.

2.3 Preparations

The following items will be performed in preparation for each soil sampling event:

- Review project objectives with all personnel and identify locations to be hand augered or sampled.
- Review sampling locations, sampling equipment and supplies, time of sampling, and schedule of analyses to be performed.
- Review health and safety procedures with all field personnel.
- Review appropriate permits, insurance requirements, contractual requirements, and site access procedures, if applicable.
- Inform laboratory of expected sample shipments.
- Obtain containers of organic-free water from the laboratories for preparation of field blanks. The purpose of the field blanks is to identify potential contamination associated with ambient conditions, or with sampling techniques and methodologies.
- Obtain from the laboratory trip blank water vials containing organic-free water for VOC analyses at a rate of two vials for each ice chest containing samples for VOC analysis. Trip blanks will be prepared by the laboratory using organic-free water. The purpose of the trip blanks is to identify potential contamination associated with container preparation and sample transport.

2.4 Procedures

The following procedures will be performed for collecting surface (concrete or asphalt) samples:

- Collect surface samples from the designated locations using clean, decontaminated hammers, chisels, and stainless steel trowels.

STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES

Omega Chemical Site PRP Organized Group
Whittier, California

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- Collect surface samples in clean 9-ounce glass jars using hand trowels. Collect and pack samples in such a fashion as to achieve minimum headspace.
- Secure the glass jars with custody seals and attach a sample label. Place each sample jar in a resealable plastic bag and immediately store sample jars on ice in an ice chest.
- Complete appropriate chain-of-custody records and laboratory analysis request forms.
- Package and store samples and transport or transmit to laboratory within 24 hours after sample collection.

The following procedures will be performed for collecting soil samples below land surface (hand auger samples):

- Decontaminate 6-inch brass sample tubes and single-tube sampler.
- Place appropriate number of clean 6-inch brass sample tubes into the sampler body. Store the split-tube sampler in a cool place prior to use. Attach sampler to slide hammer or drill rod and drive the sampler 6 inches into the formation.
- After the sampler is retrieved, carefully remove and examine the sample tube(s). If more than one sample tube is used, the two lower tubes will be used for chemical analyses and lithologic evaluation, as necessary. Soil in the other tube will be discarded.
- Seal ends of sample tubes with Teflon liner and plastic end caps. Secure caps with laboratory film and attach sample label. Place each sample tube in a resealable plastic bag and immediately store sample tubes on ice in an ice chest.
- Prepare one equipment rinsate sample each day. Equipment rinsate samples are prepared using rinsate water from the distilled water rinse of the single-tube sampler. Analyze the equipment rinsate sample for the same analytes as the soil samples.
- Complete appropriate chain-of-custody records and laboratory analysis request forms.
- Package and store samples and transport or ship to laboratory within 24 hours after sample collection.

STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES

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2.5 Sample Containers, Preservation, and Transmittal

Concrete and asphalt soil samples will be collected in 9-ounce glass jars provided by the laboratory, while soil samples will be collected in clean brass or stainless steel sample tubes.

Brass or stainless steel sample tubes used for collection of soil samples below land surface will be 2 inches in diameter and 6 inches in length. Soil samples collected will be labeled, placed in resealable plastic bags, and immediately stored on ice in an ice chest. Soil samples will be transported or transmitted to the laboratory on ice in sealed ice chests containing chain-of-custody records and analysis request forms. Samples will be delivered or shipped to the laboratory at the end of each sampling day.

2.6 Equipment Decontamination and Disposal

Prior to the collection of each soil sample, the 6-inch sample tubes and sampler will be washed with non-phosphate detergent, followed by a tap water rinse and a final, distilled water rinse. Hammers, chisels, and hand trowels used for collection of concrete and asphalt samples will undergo this same procedure. After cleaning of soil samplers and sample tubes, they will be stored in resealable plastic bags and kept cool. Excess soil and decontamination fluids will be contained and properly disposed.

2.7 Documentation

Documentation of the sampling activities will include records of sampling events in the field notebook, sample identification documents, and transmittal letters to the laboratory. Sample identification will be conducted in accordance with the QAP.

The field notebook will be the responsibility of the field team leader. All entries will be signed and dated and the field notebook will be kept as a permanent record. The following information will be entered into the field notebook each time a soil, concrete, or asphalt sample is collected:

- sample location/identifier
- depth at which sample was collected
- date and time sample was collected
- any detected organic vapors
- analyses to be performed
- sample lithologic description (if applicable)
- any other pertinent information, including any difficulties in sampling or unusual drilling occurrences.

STANDARD OPERATING PROCEDURES FOR FIELD ACTIVITIES

Omega Chemical Site PRP Organized Group
Whittier, California

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2.8 Quality Assurance

QA for soil, concrete, and asphalt samples collected during this investigation will be accomplished by following the procedures described in this SOP and by analytical laboratory QA procedures. In addition, the following field quality control methods will be implemented during sample collection:

- Collect one equipment rinsate blank sample daily when soil, concrete, or asphalt samples are being collected. Sampling personnel will prepare the field blanks at a predetermined sample location using organic-free water obtained from the analytical laboratory. The purpose of the field blank is to identify possible contamination associated with sample collection and transport.
- Include one trip blank sample containing organic-free water for HVOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using organic-free water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.
- Duplicates will be collected for approximately 10% of the soil, concrete, and asphalt samples collected. Duplicates will be collected during the same sampling episode, in as close proximity as possible, and will be independently analyzed for the same suite of analytes as primary samples.
- Prior to the start of each sampling round, the Field Task Manager will determine the sampling locations for QA samples, and will specify labeling procedures for these samples.

3.0 CONE PENETROMETER TESTING (CPT)

3.1 General Statement

A cone penetrometer test (CPT) rig may be used to collect subsurface geologic, hydrogeologic, and groundwater data. The CPT rig utilizes an hydraulically driven, direct-push, instrumented rod to gather data on subsurface conditions. Computers at the surface collect information about tip resistance, sleeve resistance, pore pressure, and/or electrical resistivity from the instrumented tip of the rod (the "cone"). Analysis of these values and their varying ratios yields detailed information about subsurface lithology and depth to groundwater.

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Electrical resistivity measurements may be taken to indicate the presence of free phase light, non-aqueous phase liquids (LNAPLs). LNAPLs will only be detected, however, when the layer's thickness exceeds the spacing of the electrodes, typically one to two inches.

3.2 Sampling Equipment

In addition to collecting information on subsurface lithology and hydrogeology, the CPT rig may be used for collection of groundwater samples through the use of the HydroPunch™ or BAT sampling systems. The operating procedures for these techniques are discussed in Section 4.0 below.

The CPT rig may be used for direct-push collection of soil samples as well. The operating procedures for this activity are discussed in Section 5.0 below.

3.3 Preparation

Prior to cone penetrometer testing, the following will be determined and discussed with field personnel:

- Objectives of the testing event.
- Location and number of test locations.
- Schedule of data analyses to be performed.
- Health and safety procedures for all personnel.
- Appropriate permits, utility clearances, insurance requirements, contractual requirements, and site access procedures, if applicable. Underground Service Alert will be contacted to mark underground utilities in the vicinity of the proposed CPT locations.

A qualified contractor will be selected to conduct cone penetrometer testing. The qualified contractor will have the appropriate equipment capabilities, a California drilling contractor license, experience on hazardous waste sites, and Occupational Safety and Health Administration (OSHA)-trained operators.

3.4 Procedures

The CPT rig will push the instrumented cone at a continuous rate to the target depth at each proposed location. Subsurface parameters to be recorded will include tip resistance, sleeve friction, and dynamic pore pressure. Other parameters may be monitored as warranted; the decision to include additional analyses will be at the discretion of the field hydrogeologist.

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3.5 Equipment Decontamination and Disposal

The CPT instrumented cones and rods will be steam cleaned before each use.

3.6 Documentation

Documentation of CPT testing will include field notebook records, CPT contractor field data printouts, and the CPT contractor's final report on subsurface conditions.

The field notebook will be kept as a permanent record and will be signed and dated by the field hydrogeologist. The following information will be entered into the field notebook each time CPT "boring" is advanced:

- test location/identifier
- depth interval
- date and time
- types of data collected/analyses performed
- other pertinent information.

3.7 Quality Assurance

All CPT soundings shall be performed in accordance with ASTM Standard D3441. A complete set of baseline readings shall be taken prior to each sounding to determine temperature shifts and zero load offsets.

4.0 GROUNDWATER MEASUREMENT AND SAMPLE COLLECTION

4.1 General Statement

Groundwater levels will be measured and groundwater samples will be collected using the HydroPunch® or BAT® sampling mechanisms. The HydroPunch™/BAT® sampling systems are typically advanced using a CPT rig. The CPT rig is preferred for reconnaissance groundwater sampling due to the potential for a large number of sample points per day, a significant reduction in soil cuttings produced (compared to drilling), and minimal impact to the site.

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4.2 Sampling Equipment

Because of the above-described factors, the use of a CPT rig has been selected for the Omega site. If the CPT rig reaches refusal above the target depth, standard hollow-stem auger techniques may be used to advance the sampling system.

4.3 Preparation

A qualified contractor will be selected to conduct the reconnaissance groundwater sampling. The qualified contractor will have the appropriate equipment capabilities, a California drilling contractor license, experience on hazardous waste sites, and Occupational Safety and Health Administration (OSHA)-trained operators.

Prior to commencing a sampling event, the following information will be determined and reviewed with all field personnel:

- Inform laboratory of expected sample shipment.
- Obtain the appropriate sample containers from the laboratory.
- Obtain containers of organic-free water from the laboratories for preparation of field blanks. The purpose of the field blanks is to identify potential contamination associated with ambient conditions in the vicinity of monitor wells or with sampling techniques and methodologies.
- Obtain from the laboratory trip blank water vials containing organic-free water for VOC analyses at a rate of two vials for each ice chest containing samples for VOC analysis. Trip blanks will be prepared by the laboratory using organic-free water. The purpose of the trip blanks is to identify potential contamination associated with container preparation and sample transport.

Permits will be obtained from the appropriate agencies to conduct reconnaissance groundwater sampling prior to commencing work. Underground Service Alert will be contacted to mark underground utilities in the vicinity of the sampling locations.

4.4 Procedures

The CPT rig will push the sampling system to a target depth of approximately 5-10 feet below the water table at each location. Groundwater samples will be collected using either the

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HydroPunch™ or BAT® system. Groundwater levels will be measured, and the CPT sampling holes will be grouted from bottom to top using a tremie pipe.

The HydroPunch™ groundwater sampling system consists of a sampling tool that is pushed to target depth, then withdrawn approximately 4 feet to expose the intake screen. Check valves prevent the HydroPunch™ sampling tool from draining as it is recovered. Sample containers are filled using a stopcock fitted on the sampling tool.

The BAT® sampling system utilizes a permanent filter tip in direct contact with formation; the sample is collected with a disposable syringe in an evacuated glass container.

4.5 Water Level Determination

Ground surface elevations at each monitoring point will be surveyed by a California-licensed surveyor. Groundwater levels will be measured using an electrical water level sounder lowered down the center of the CPT drive pipe to the HydroPunch-screened drive tip, an Enviro Probe pore pressure transducer lowered to the BAT sampling tip, or a water sounder lowered down the center of a temporary well point installed in the CPT borehole. Repeatable groundwater level measurements within 0.01 foot are expected.

4.6 Sample Containers, Preservation, and Transmittal

The types and volumes of sample containers used will depend upon whether the HydroPunch™ or BAT® groundwater sampling system is used. The BAT® system utilizes proprietary pre-cleaned, evacuated glass containers. If the HydroPunch™ system is used, glass sample vials provided by the analytical laboratory will be used.

4.7 Equipment Decontamination and Disposal

The groundwater sampling system and extension rod will be steam cleaned before each use. The groundwater sampling system will be washed with non-phosphate detergent, followed by a tap water rinse and a final, distilled water rinse.

All materials generated during HydroPunch™/BAT® groundwater sampling activities will be contained and temporarily stored in appropriately labeled 55-gallon drums until an appropriate disposal option is determined.

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4.8 Documentation

Documentation of the reconnaissance groundwater sampling activities will include field notebook sampling records, sample identification documents, and Chain-of-custody forms. Sample identification will be conducted in accordance with the QAP.

The field notebook will be kept as a permanent record and will be signed and dated by the field hydrogeologist. Erroneous entries will be corrected by crossing a line through the error and entering the correct information. Corrections will be initialed by the person making the re-entry. The following information will be entered into the field notebook each time a groundwater sample is collected:

- groundwater sampling system used
- depth to groundwater and description of the measurement reference point
- ground surface elevation
- sample collection procedures
- sample volume collected
- sample location/identifier
- sampling depth
- sampling date and time
- analytical method
- other pertinent information.

4.9 Quality Assurance

QA for groundwater samples collected during routine groundwater monitoring will be accomplished by following the procedures described in this SOP and by analytical laboratory QA procedures. In addition, the following field quality control methods will be implemented during sample collection:

- Collect one field duplicate sample for every 10 samples collected during the sampling round. Send duplicate samples along with original samples to the primary laboratory. The purpose of the duplicate sample is to determine the precision of field sampling and laboratory analysis techniques.
- Collect one split sample for every 10 samples collected during the sampling round. Send split samples to the State-certified check laboratory for analysis. The purpose of the split sample is to confirm the compounds and concentrations detected in the samples analyzed by the primary laboratory.

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- Collect one field blank sample for every 10 samples collected during the sampling round. Sampling personnel will prepare the field blanks at a predetermined sample location using organic-free water obtained from the analytical laboratory. The purpose of the field blank is to identify possible contamination associated with sample collection and transport.
- Include one trip blank sample containing organic-free water for VOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using organic-free water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.
- Prepare split samples for EPA or other agencies during groundwater sampling, if required, by alternately filling agency and England/Hargis sample containers in sequential order for each parameter until all containers are filled.
- Identify duplicates and blank samples in the same manner as all other samples. Identifiers will be determined prior to the sampling round.
- Prior to the start of each sampling round, the Field Task Manager will determine the sampling locations for split sample collection, field blank preparation, and duplicate sample collection. Additionally, the Field Task Manager will specify labeling procedures for these samples.

5.0 DIRECT PUSH SOIL SAMPLING USING CPT RIG

5.1 General Statement

Soil samples will be collected using the a direct push sampling mechanism. This system is commonly typically advanced using a CPT rig. The CPT rig is preferred for reconnaissance soil sampling due the significant reduction in soil cuttings produced (compared to drilling), and minimal impact to the site.

5.2 Sampling Equipment

Because of the above-described factors, the use of a CPT rig has been selected for the Omega site. If the CPT rig reaches refusal above the target depth, standard hollow-stem auger techniques may be used to collect samples.

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5.3 Preparation

A qualified contractor will be selected to conduct CPT soil sampling. The qualified contractor will have the appropriate equipment capabilities, a California drilling contractor license, experience on hazardous waste sites, and Occupational Safety and Health Administration (OSHA)-trained operators.

Prior to commencing a sampling event, the following information will be determined and reviewed with all field personnel:

- Inform laboratory of expected sample shipment.
- Obtain containers of organic-free water from the laboratories for preparation of equipment rinsate blanks. The purpose of the equipment rinsate blanks is to identify potential contamination associated with sampling techniques and methodologies.
- Obtain from the laboratory trip blank water vials containing organic-free water for VOC analyses at a rate of two vials for each ice chest containing samples for VOC analysis. Trip blanks will be prepared by the laboratory using organic-free water. The purpose of the trip blanks is to identify potential contamination associated with container preparation and sample transport.

Permits will be obtained from the appropriate agencies to conduct sampling prior to commencing work. Underground Service Alert will be contacted to mark underground utilities in the vicinity of the sampling locations.

5.4 Procedures

The CPT rig will push the sampling system to the designated target depth at each location. Soil samples will be collected using a direct drive system, with stainless steel or brass sample liners. Upon completion of all relevant sampling, the CPT sampling holes will be grouted from bottom to top using a tremie pipe.

The direct drive soil sampling system consists of a sampling tool that is pushed to the target depth; the drive shoe is then withdrawn. When the drive rod is advanced, soil enters one or two 6-inch brass or stainless steel sample liners. The sampler is then withdrawn, the sample ends are covered with Teflon and capped, and the samples are stored.

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5.5 Sample Containers, Preservation, and Transmittal

Brass or stainless steel sample tubes used for collection of soil samples below land surface will be 1 to 2 inches in diameter and 6 inches in length. Soil samples collected will be labeled, placed in resealable plastic bags, and immediately stored on ice in an ice chest. Soil samples will be transported or transmitted to the laboratory on ice in sealed ice chests containing chain-of-custody records and analysis request forms. Samples will be delivered or shipped to the laboratory at the end of each sampling day.

5.6 Equipment Decontamination and Disposal

The CPT soil sampling system and extension rod will be steam cleaned before each use. The sampling system will be washed with non-phosphate detergent, followed by a tap water rinse and a final, distilled water rinse.

All materials generated during CPT soil sampling activities will be contained and temporarily stored in appropriately labeled 55-gallon drums until an appropriate disposal option is determined.

5.7 Documentation

Documentation of CPT soil sampling activities will include field notebook sampling records, sample identification documents, and chain of custody forms. Sample identification will be conducted in accordance with the QAP.

The field notebook will be kept as a permanent record and will be signed and dated by the field hydrogeologist. Erroneous entries will be corrected by crossing a line through the error and entering the correct information. Corrections will be initialed by the person making the re-entry. The following information will be entered into the field notebook each time a soil sample is collected:

- sample location/identifier
- depth at which sample was collected
- date and time sample was collected
- any detected organic vapors
- analyses to be performed
- sample lithologic description
- any other pertinent information, including any difficulties in sampling or unusual drilling occurrences.

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5.8 Quality Assurance

QA for CPT soil samples collected during this investigation will be accomplished by following the procedures described in this SOP and by analytical laboratory QA procedures. In addition, the following field quality control methods will be implemented during sample collection:

- Collect one equipment rinsate blank sample daily when CPT soil samples are being collected. Sampling personnel will prepare the equipment rinsate blanks at a predetermined sample location using organic-free water obtained from the analytical laboratory. The purpose of the equipment rinsate blank is to identify possible contamination associated with sample collection and transport.
- Duplicate samples will be collected at approximately one in ten deep soil sampling locations, and submitted for independent analysis.
- Include one trip blank sample containing organic-free water for HVOC analyses to accompany each ice chest shipped each day for these analyses. The trip blanks will be prepared by the analytical laboratory using organic-free water. The purpose of the trip blank is to identify possible contamination associated with container preparation and sample transport.
- Prior to the start of each sampling round, the Field Task Manager will determine the sampling locations for QA sample preparation, and will specify labeling procedures for these samples.

6.0 HANDLING, STORAGE, CHARACTERIZATION, AND DISPOSAL OF INVESTIGATION-DERIVED WASTES

SOPS have been developed for the handling, storage, characterization, and disposal of wastes generated during site investigation field work activities. Wastes generated during this investigation will include soil, water, and a limited amount of debris.

6.1 Handling and Storage

Wastes generated during this investigation will include water, soil, and debris.

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6.1.1 Water

Water will be generated during decontamination and HydroPunch™/BAT® groundwater sampling. Clearly labeled fifty-five (55)-gallon DOT-rated drums will be used to contain all water generated during this investigation. A central staging area for decontamination of drilling and sampling equipment will be established on the site. Water generated during decontamination procedures will be contained at this location.

6.1.2 Soil and Debris

Soil cuttings and debris will be generated during soil sampling and other activities. These materials will be stored in 55-gallon drums at each sample location. Each container will be clearly labeled with the soil boring identifier, date, and depth interval for soil cuttings contained (as applicable).

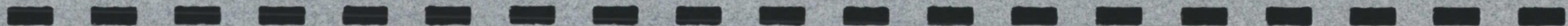
6.2 **Characterization**

Characterization of soil and liquids will be required to determine appropriate methods of waste disposal. The analytical results for soil samples collected from soil borings will be used to characterize any soil generated during soil sampling activities. Samples of decontamination and well purge water will be collected from each 55-gallon drum after it is filled to capacity. These samples will be analyzed for HVOCs (EPA Method 601/8010)

6.3 **Disposal**

All water generated during this investigation will be temporarily stored in 55-gallon drums. Disposal of these and other wastes generated during this investigation will be based upon analytical results for waste characterization samples. Upon completion of the requisite laboratory analyses, a Technical Memorandum will be issued to EPA outlining the recommended disposal option.

The Omega PRP Organized Group (OPOG) will be responsible for disposal of all wastes generated during field activities.



QUALITY ASSURANCE PROGRAM
Omega Chemical Site
12504 and 12512 East Whittier Boulevard
Whittier, California
Project No. 399-A

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1.0 INTRODUCTION

This Quality Assurance Program (QAP) has been prepared by England & Associates and Hargis + Associates, Inc. (England/Hargis) on behalf of the Omega Potentially Responsible Parties Organized Group (OPOG) for the Omega Chemical Facility site located at 12504 and 12512 East Whittier Boulevard, Whittier, California (the site).

1.1 Purpose and Scope

This Workplan and QAP have been prepared in accordance with EPA guidelines (EPA, 1988a, 1988b, 1989a, 1989b, and 1993). This QAP describes the quality assurance/quality control (QA/QC) procedures for the collection, identification, preservation, and transport of samples collected during field activities; the calibration and maintenance of instruments; and the verification, storage, and reporting of project data, including Chain-of-custody procedures. Additionally, this document identifies the QA project organization and the selected analytical laboratories.

The purpose of this QAP is to identify data quality objectives (DQOs) and to provide a framework for collecting data that meet the DQOs. The DQOs are qualitative and quantitative statements that identify the minimum level of data QA necessary to meet the intended uses of the data to be collected. QA is defined as the integrated program designed to ensure that DQOs are met. QC is a component of the QA program and is defined as the routine use of standard procedures to conform to prescribed performance criteria in the monitoring and measurement process. QC procedures are established on the basis of DQOs. The QC procedures contained in this QAP are intended to ensure that project tasks are performed in accordance with professional standards, government regulations and guidelines, and specific project goals, DQOs, and requirements. Standard operating procedures (SOPs) have been developed to ensure that field samples are collected in a manner consistent with the QA program (Appendix D).

The purpose of this investigation is to conduct surface and subsurface soil and groundwater sampling to determine the nature and extent of contamination at the site.

1.2 Project Tasks

Five field tasks have been identified for this project. The DQOs and QC procedures for these tasks are described in this QAP. This QAP describes QC procedures to be used during the following tasks to ensure that QA objectives are met:

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- **Existing Data Review.** This evaluation will be conducted to characterize the geologic setting and hydrogeologic conditions beneath the site vicinity and to identify known and potential sources of groundwater contamination in the vicinity of the site. This evaluation will be conducted using existing published information or information available from public or private sources.
- **Shallow Soil Gas Survey.** A shallow soil gas survey will be conducted to determine the horizontal extent of soil contamination by halogenated VOCs (HVOCs) and to evaluate optimum locations for shallow soil sampling. The specific suite of soil gas analytes is based upon guidelines established by the Regional Water Quality Control Board, Los Angeles Region (RWQCB) (RWQCB, 1994).
- **Shallow Soil Sampling.** Shallow soil sampling will be conducted to evaluate the nature and extent of shallow soil contamination and to evaluate optimum locations for depth-specific groundwater sampling. Soil samples will be collected using drive-sampling techniques in shallow borings drilled using a hand auger. Specific locations for soil sampling will be based upon visual inspection, information on past uses of specific areas of the site, and the results of the shallow soil gas survey and near-surface material sampling. Analytical methods and handling protocols for soil sampling are summarized in Table 1. It is expected that the one-foot sample will be adequate to detect "grossly contaminated" near-surface materials (soil, asphalt, or concrete). If such materials appear closer to the surface than one foot, they will be sampled as well.
- **Location and Evaluation of Existing Well BMW-1.** Monitoring well BMW-1 will be located and its condition will be evaluated. This task does not include any field data collection and this will not be referenced further in this appendix.
- **Deep Soil Sampling and Groundwater Sampling.** Cone penetrometer testing, deep soil sampling, and HydroPunch™/BAT₂ depth-specific groundwater sampling will be conducted to provide data to assess the chemical quality of deep soil and groundwater beneath the site.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization chart lists personnel responsible for implementation of project tasks (Figure 5). QA activities at the site will be overseen by a QA team comprised of the following project personnel: project manager and task manager. The QA team is responsible for ensuring that valid measurement data are obtained and for routinely

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assessing laboratory and field measurement data. The following sections describe the responsibilities of individual members of the QA team.

2.1 Project Manager Responsibilities

The project manager is responsible for general project supervision to ensure that all field and laboratory activities meet project objectives. The project manager will:

- Act as project liaison with OPOG and EPA.
- Ensure that the procedures specified in this QAP are implemented and that all field activities meet stated objectives.
- Determine sampling and analytical strategies with the assistance of the task manager.
- Approve, designate, and monitor corrective action for all field and office activities, as needed.
- Review project documents.

2.2 Task Manager Responsibilities

The task manager is responsible for overseeing all field activities, for communicating field activities with the project manager, and for coordinating all sampling efforts. The task manager is also responsible for informing field personnel, prior to field work, of the QC practices to be employed; for performing and overseeing QA/QC functions during the course of the project; and for communicating QA/QC status and requirements to the project manager. The task manager will:

- If necessary, contact off-site private property or facility owners and obtain permission to conduct field activities.
- Coordinate field activities with all subcontractors and establish contractual agreements, as necessary.
- Provide training for all sampling personnel, as necessary. Training may include sample collection procedures, decontamination procedures, and sampling documentation procedures.

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- Coordinate all sampling efforts with field personnel and with the analytical laboratories.
- Designate sampling locations and assign sample identifiers for associated QC samples, including trip blanks, field blanks, field duplicates, and split samples, as required.
- Ensure that all field supplies and equipment, including sampling equipment, bottles, labels, custody seals, preservatives, and shipping supplies necessary to properly collect and document samples, are available and in good working order.
- Ensure that field personnel adhere to the procedures documented in this QAP unless field conditions require project modifications.
- Review field notebooks and ensure that all appropriate field data forms are complete and correct.
- Coordinate QA/QC functions with the project manager.
- Review and approve all QA/QC documents pertaining to field activities.
- Review and approve all modifications to this QAP, as necessary, and distribute modifications to relevant parties.
- Maintain a record of all samples submitted for analysis to the laboratories, the analyses performed, and the final results.
- Ensure that proper sample custody procedures are followed.
- Review Chain-of-custody records and sample transmittal documents for completeness.
- Perform assessment and validation of the quality of data and review analytical results with project personnel.
- Coordinate corrective action, as necessary, for all field activities.
- Monitor progress in correcting laboratory deficiencies.

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The task manager may designate technical staff to assist in these responsibilities, as appropriate.

3.0 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the minimum level of data quality assurance necessary to meet the intended uses of the data to be obtained (EPA, 1994d). DQOs are initially identified during project scoping and are incorporated into the QAP to provide implementable objectives that ensure that the data obtained during field activities are of a quality consistent with their intended uses. Major data use categories for data obtained during field sampling, field measurement, and testing activities are summarized in Table 2. QA objectives are established to provide criteria for evaluating the measurement process to ensure that the resultant data satisfy each DQO established for the activity (Table 3).

3.1 Data Quality Objectives for Field Tasks

DQOs were also used in the development of the Workplan; the Workplan describes the following:

- Objectives for the various sampling efforts to be performed.
- Rationale for the selection of sampling locations, number of samples, and analytical parameters.
- Detailed descriptions of sampling procedures and analytical methods.

The following sections briefly summarize the DQOs for sampling, field measurement, and testing activities at the site. Each section identifies the analytical procedures to be used, if applicable. Detailed discussions of scope are found in Section 3.0 of the Workplan, while procedural details are described in Appendix C.

3.1.1 Existing Data Review

This evaluation will be conducted using existing information that has been published or is otherwise available from public or private sources. Data compiled during this review will be evaluated in accordance with procedures outlined in this QAP, as applicable. The DQO of the regional hydrogeologic data evaluation is to provide data that are of sufficient quality

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to support decisions made during the course of the project and that are representative of actual site and regional conditions.

3.1.2 Shallow Soil Gas Survey

The DQO of shallow soil gas sampling is to provide data that are of sufficient quality to determine the nature and extent of shallow soil gas contamination on-site and to guide the shallow soil and groundwater sampling field tasks. The DQO of this task will be achieved by implementing QC procedures for soil gas sampling, by conforming to the SOPs provided in the Workplan, and by conforming to specific QA objectives for soil gas sampling activities (Table 3). The rationale for soil gas sampling methods and procedures is provided in the Workplan.

3.1.3 Shallow Soil Sampling

The DQO of shallow soil sampling is to provide data that are of sufficient quality to characterize the nature and extent of shallow soil contamination that is representative of actual site conditions and to guide the subsequent groundwater sampling/testing program. The DQO of this task will be achieved by implementing QC procedures for soil sampling, by conforming to the SOPs provided in Appendix C, and by conforming to specific QA objectives for soil sampling activities (Table 3).

3.1.4 Deep Soil Sampling

The DQO of deep soil sampling is to provide data that are of sufficient quality to characterize the nature and extent of deep soil contamination that is representative of actual site conditions and to guide the subsequent groundwater sampling/testing program. The DQO of this task will be achieved by implementing QC procedures for soil sampling, by conforming to the SOPs provided in Appendix C, and by conforming to specific QA objectives for soil sampling activities (Table 3).

3.1.5 Groundwater Sampling

The DQO of depth-specific groundwater sampling is to provide data that are of sufficient quality to characterize the lateral extent of on-site groundwater contamination, and that are representative of actual site conditions. The DQO of this task will be achieved by conforming to sampling tool manufacturer-recommended procedures and by implementing QC procedures for depth-specific groundwater sample collection included in the SOPs (Appendix C). Groundwater samples will be collected in a manner consistent with the SOPs

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to ensure that the data obtained from depth-specific groundwater samples are representative of actual site conditions.

3.2 Data Quality Objectives for Laboratory Analyses

BC Analytical (BCA), Anaheim, California, is the designated primary analytical laboratory for organic and inorganic analyses of original project groundwater samples. Del Mar Analytical (Del Mar), Irvine and Colton, California, is the designated check laboratory for analyses of project split samples, if required. HydroGeoChem, Inc. (Huntington Beach, California) is the designated mobile analytical laboratory for organic analyses of soil gas samples. Laboratory QA/QC procedures for the respective laboratories are provided in Appendices F and H.

DQOs of laboratory analysis will be achieved in the laboratory by applying project-specific control limits for QC samples, including matrix spike samples, matrix spike duplicate (MSD) samples, laboratory duplicate samples, internal standards, surrogates, and laboratory control standards (LCSs). Laboratory data quality will be assessed for precision, accuracy, representativeness, completeness, and comparability (PARCC). Project-specific reporting detection limits (RDLs) and QC limits have been established for analysis of the target analytes (Tables 4 through 9).

3.3 Data Quality Objectives for Field Measurement Activities

Field measurement activities will include measurement of some or all of the following field parameters: air quality, and water levels, and field parameters.

The DQOs of field measurement data have been specified for accuracy and completeness parameters (Table 3). These DQOs will be achieved by conforming to the SOPs provided in Appendix C, and by implementing field measurement QC procedures. Data assessment and validation procedures will be used to determine the achievement of DQOs for chemical analyses.

3.3.1 Conduct Air Monitoring

Air monitoring will be performed during shallow soil sampling, near-surface materials sampling, and any groundwater sampling. Air monitoring will be performed using an organic vapor analyzer to monitor the air quality in the breathing zone of on-site workers. Air monitoring will be performed in accordance with the health and safety procedures

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provided in the HSP (Appendix B) and with manufacturer specifications to ensure that the data obtained are representative of actual site conditions.

The DQO of air monitoring is to provide data that are of sufficient quality to evaluate the safety of field personnel and that are representative of actual site conditions. The DQO will be achieved by conforming to the SOPs for air monitoring provided in the HSP and manufacturer specifications (Appendix B).

3.3.2 Measure Water Levels

Water levels will be measured in CPT soundings to determine horizontal hydraulic gradients. Resulting data may be used to construct water level contour maps. Water levels will be recorded on standard forms (Table 10). Recorded data will include the depth to water in feet below the measuring point, the date and time of measurement, and the calculated water level elevation.

The DQO of water level measurement is to provide data that are of sufficient quality to support decisions made during field activities and that are representative of actual site conditions. The DQO will be achieved by implementing QC procedures for water level measurement, by conforming to the SOPs provided in the Workplan for water level measurement, and by conforming to specific QA objectives for water level measurements (Table 3).

4.0 QUALITY ASSURANCE MANAGEMENT

The following sections summarize the data quality management program and the quality assurance oversight program, conducted to fulfill the QA requirements of this project.

4.1 Data Quality Management

The data quality management program is designed to ensure that QC procedures are adhered to from data collection to report preparation. Data obtained during sampling and field measurement activities will be used to make decisions with regard to sampling activities. Data quality management will be initiated prior to data collection by implementing QC procedures established to ensure that all data are obtained and analyzed in a manner consistent with QA objectives and are representative of the actual site conditions. The following sections summarize field and laboratory data quality management and assessment for project activities.

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4.1.1 Data Management

Field and laboratory data will be managed as they are obtained and compiled. Field data will be obtained and compiled on daily field activity forms (Tables 11 through 15). Laboratory data will be compiled in the data report packages. Tables will be prepared based on these data for use in data submittals and summary reports. Use of these standard data reporting forms and tables will ensure that data are presented in a consistent manner.

4.1.1.1 *Field Data*

The task manager will retain all daily field activity forms and copies of all field data forms in the project file. Field data files, including well information and field sampling files, will be established for all field activities. These data files will contain original data and field notes. All files will be well organized, indexed, verified, and accessible.

Well information files will be compiled for regional production and monitor wells. Well information files will include the following, if available:

- Field notes compiled during drilling operations.
- Lithologic or driller's log forms.
- Schematic well construction diagrams illustrating as-built well construction details.
- Field notes compiled by project personnel during activities such as regional well inspection.

Field sampling files will be compiled for all sampling activities. Field sampling files will include the following information:

- Field notes compiled by sampling personnel during a sampling event or preparation for sample collection.
- Field data forms, as appropriate.
- Sample documentation forms, including Chain-of-custody records, transmittal letters, and courier receipts.

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Field data files will be compiled for all other field activities. Field data files will include the notes compiled by field personnel on Daily Field Activity Forms.

4.1.1.1.1 Analytical Data

Analytical data files will be established for all project activities. These data files will be well organized, indexed, verified, and accessible. Analytical data will include transmittal letters, original Chain-of-custody records, and laboratory data packages assembled by each laboratory performing analyses. These laboratory data packages will be provided by the laboratory to England/Hargis as hard copy. Analytical data and laboratory QC data may also be provided on a diskette. The task manager will maintain all original transmittal letters, Chain-of-custody records, field data forms, and the laboratory data packages in the project files.

Analytical data files compiled for analyses performed during project activities will include the following information:

- Original Chain-of-custody records.
- Laboratory analytical reports from all sampling events.
- QC sample results, including field duplicates, blanks, laboratory QC samples, and, if required, splits.
- Data deliverables packages.
- Assessment and validation forms compiled during data evaluation.

4.1.2 Data Assessment and Data Validation

Data generated during sampling events will be assessed and validated to determine if they meet project-specific QC criteria (Tables 4 through 9). The quality and appropriate use of data obtained during sampling activities will be determined based on the results of routine assessment of 100 percent of the data and on the results of validation procedures performed on approximately 10 percent of the data. SOPs for data assessment and data validation will be followed to ensure that these activities are performed in a consistent manner.

Analytical data generated during sampling activities will be assessed for PARCC parameters. Assessment and validation of analytical data will be performed under the supervision of the

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task manager. Laboratories are required to submit analytical results that are supported by sufficient information to enable the reviewer to fully evaluate data quality.

The task manager will direct the following activities during the analytical data assessment process:

- Review of Chain-of-custody records
- Review of sample holding times
- Review of field blank and trip blank results
- Review of field duplicate and, if required, split sample results
- Review of laboratory reagent blank, spike, surrogate, and duplicate sample results

Data assessment results will be used to flag questionable analytical results and to assign data qualifiers. The results will also be used as a basis to request revised analytical data reports from the laboratory and to initiate corrective action. In addition, results will be used to determine corrective action required for field sampling personnel.

Approximately 10 percent of the samples will be selected for data validation. Documentation provided by the laboratory for these samples will be sufficient to support Level III contract laboratory program (CLP) type analysis for VOCs (EPA, 1990a). Data validation is a systematic process of evaluating analytical data against a pre-established set of QC criteria to determine the quality of the data (EPA, 1994a and 1994b). The support documentation required from each laboratory to prepare data validation packages will be specified to the laboratory. Data validation packages will be assembled by the laboratories performing analyses.

The task manager will direct the following activities during the analytical data validation process:

- Review of sample holding times
- Review of initial and continuing calibration procedures and results
- Review of instrument performance results
- Review of reagent blank, surrogate, spike, spike duplicate or laboratory duplicate, LCS, and interference check sample results

The data validation program will include (1) the analytical laboratories' internal Quality Assurance Program (Appendices F and H), (2) establishment of England/Hargis minimum criteria for PARCC parameters, and (3) 10% formal review of Quality Control procedures,

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including holding times, detection limits, blanks, surrogate spikes, matrix spikes and spike duplicates, and field duplicates.

The results of data validation will be used in conjunction with other validation criteria to flag questionable analytical results and to assign data qualifiers. The results will also be used as a basis to request revised analytical data reports from the laboratory and to initiate corrective actions.

The results of data assessment and validation, including the activities described above and any data qualified, will be compiled for each sampling event. These results will be kept on file with a memorandum that explains the reasons for data qualifications and that indicates corrective action to be implemented.

4.1.3 Precision, Accuracy, Representativeness, Completeness, and Comparability Parameters

Throughout sampling activities, routine procedures will be used to maintain PARCC parameters, depending on the DQOs for the sampling event. Descriptions of the PARCC parameters to be evaluated during data assessment are described below:

4.1.3.1 *Precision*

Precision is a measure of the agreement or reproducibility among replicate measurements (EPA, 1989a). Precision is expressed as the relative percent difference (RPD) between duplicates of the same sample. Duplicates consist of internal laboratory duplicates and external field duplicates. Internal laboratory duplicates include sample duplicates and/or MSDs, depending on the analytical method. Analytical results from field duplicate samples provide information on the precision of sample collection procedures. Analytical results from laboratory duplicates and laboratory MSDs provide data on laboratory precision. The RPD between duplicate sample results is calculated using the following equation:

$$RPD = \frac{(D1-D2)}{(D1+D2)/2} \times 100$$

where: RPD = relative percent difference
D1 = first sample value
D2 = second sample value (duplicate).

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The RPDs are compared to established project-specific precision control limits (Tables 4 through 9). Unacceptable precision values will be noted in the project file. Data associated with unacceptable laboratory precision results will be qualified, and recommendations for corrective action will be discussed with the laboratory or field personnel, as appropriate.

4.1.3.2 Accuracy

Accuracy is the degree of agreement between a measured value and an accepted reference or true value (EPA, 1989a). Accuracy can be expressed numerically as the percent recovery of a spiked sample. A sample spike is prepared in the laboratory by adding a known concentration of one or more chemicals to one sample in each analytical batch. The chemicals spiked are chosen from the list of analytes detectable by the method being evaluated. Analytical results from spiked samples provide data on matrix interferences.

Accuracy for the analytical measurement system is defined as the percent recovery (%R) for a spiked sample. The percent recovery is calculated as follows:

$$\%R = \frac{(A-B) \times 100}{C}$$

where: %R = percent recovery
A = measured concentration in spiked sample (sample + spike)
B = measured concentration in sample
C = known concentration of spike compound.

The calculated percent recovery results are compared to project-specific and/or EPA-specified accuracy control limits (Tables 4 through 9).

Unacceptable accuracy results will be noted in the project file. Data associated with unacceptable laboratory accuracy results will be qualified, and recommendations for corrective action will be discussed with the laboratory and/or field personnel, as appropriate.

Accuracy may be qualitatively assessed by evaluating blank contamination. Compounds detected in field blanks, trip blanks, and laboratory blanks will be evaluated during the assessment procedures. Guidelines have been established to evaluate the effects of blank contamination on the accuracy of the analytical results of associated field samples. Unacceptable levels of blank contamination will be noted in the project file. Data associated with unacceptable blank results will be qualified, and recommendations for corrective action will be discussed with the laboratory and/or field personnel, as appropriate.

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4.1.3.3 *Representativeness*

Representativeness is a qualitative assessment of the degree to which a measurement or measurement system reflects a system's true conditions (EPA, 1989a). Representativeness is influenced by the number and location of the sampling points, sampling timing and frequency during monitoring events, and field and laboratory sampling procedures (EPA, 1989a).

Representativeness is addressed through proper design of the sampling program. Sample locations may be determined based on pre-existing data, instrument surveys or observations, or through random selection. Data used to select sample locations may include water level measurements, soil gas sample results, water and soil sample results, geologic descriptions such as lithologic logs, and interpretations of site vicinity hydrogeologic conditions.

If applicable, previously obtained data will be evaluated against standards outlined in this QAP for a particular type of sample collection. If information is missing, the recorded values will be assigned a lower level of confidence and may be rejected in the analysis of historical conditions.

Historical chemical data regarding the nature of soil or water conditions at the site will be similarly evaluated against the standards developed in this QAP. Unless information is available regarding the date and method of sample collection, the firm that collected the sample, the analytical methods employed, and the QA/QC procedures used, the data point will be assigned a low level of confidence.

4.1.3.4 *Completeness*

Completeness is defined as a comparison of the number of valid data points obtained from a measurement effort to the total number needed to meet the project goals (EPA, 1989a). Data completeness incorporates sample both loss and data acceptability. A completeness value of less than 90 percent indicates that corrective action is necessary to limit the number of incomplete or unacceptable results and to avoid similar problems in future sampling events.

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Analytical data completeness is calculated using the following equation:

$$C = \left(\frac{\text{number of acceptable results}}{\text{total number of requested results}} \right) \times 100$$

where: C = percent completeness.

4.1.3.4.1 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another (EPA, 1989a). Comparability is dependent on consistency in sampling conditions and on standardized sampling procedures, sample preservation methods, analytical methods, and expressed units of data.

The comparability requirements for field measurement, sampling, and analysis activities are met by complying with SOPs during sample collection and analysis.

4.2 Quality Assurance Oversight

The task manager is responsible for QA oversight. QA oversight is accomplished by verifying that established QC procedures are followed; by conducting field procedure audits on a regular basis to ensure that the data being collected are reliable, of acceptable quality, and are representative of site conditions; by identifying deficiencies and ensuring that corrective actions are implemented when necessary; and by reporting project status to project management on a regular basis.

4.2.1 Field Procedure Audits

The task manager will schedule one audit of field procedures during field activities to evaluate the execution of SOPs. The field procedure audit will consist of observations and documentation of the field activities. Field procedure audits may be performed using a standardized field audit checklist. Checklists will be used for documenting observations of sampling activities, including:

- Calibration documentation for sampling and measurement instrumentation
- Documentation of adherence to this QAP and the SOPs
- Completion of Daily Field Activity Report forms

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- Sample handling, storage, and shipping procedures
- Chain-of-custody procedures.

Observations recorded on the completed checklist will be discussed with field personnel during the audit debriefing. Specific deficiencies noted and recommendations for corrective action and follow-up will be discussed at this time. A copy of the completed checklist will be forwarded to the project manager. Depending on the severity of the deficiencies, adherence to corrective action recommendations may be verified by a follow-up audit of that deficiency.

4.2.2 Corrective Action

Results of field and laboratory data assessment, analytical data validation, and field procedure audits, and performance check samples will be used to identify deficiencies so that required corrective action may be initiated. The task manager will identify and report deficiencies to the project manager with recommendations for corrective action. Field data deficiencies and recommendations for corrective action will be discussed with field personnel during the audit debriefing. The project manager and task manager will direct the implementation of appropriate corrective action by field personnel. Depending on the severity of the deficiencies, adherence to corrective action recommendations may be verified and documented by a follow-up audit.

Analytical data deficiencies will be discussed with the laboratory and corrected as soon as possible. Laboratory performance deficiencies will be discussed with the project manager, and recommendations will be made for corrective action. Depending on the severity of the deficiencies, adherence to corrective action recommendations may be verified by a laboratory systems audit.

5.0 SAMPLE HANDLING PROCEDURES

This section summarizes SOPs for sample custody, as well as QC procedures for field measurements, sample collection, and laboratory analyses to be used during sampling activities. The purposes of these procedures are to ensure proper handling of samples during collection, transportation, storage, and analysis, and to ensure that all field measurements are performed in a manner consistent with the DQOs. Additional information on procedures for sample collection is provided in the Workplan (Section 3.0) and SOPs (Appendix C). Laboratory QC procedures used for the analysis of samples collected as part of field activities have been provided by the individual laboratories (Appendices F and H).

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5.1 Sample Collection

Soil gas samples, soil samples, near-surface material samples, and groundwater samples will be collected during field activities. The types, locations, number of samples to be collected, procedures for preparation and decontamination of sampling equipment, and methods of waste disposal were determined based on available data and the objectives established for field activities. The field sampling methodology to be employed and the laboratory analyses required for each of the sample matrices are also specified, in Section 3.0 of the Workplan, and Appendix F.

Samples will be identified, preserved, and transported in such a manner that data are representative of the actual site conditions and no information is lost in sample transport. Additional sample handling protocols have been developed for soil, near-surface material, and groundwater samples collected at the site (Table 1).

Field notebooks and copies of field data forms will be reviewed by the task manager. Field notebooks and field data forms will be retained in the project files. Transmittal letters and Chain-of-custody records will be reviewed by the task manager for completeness. The analytical laboratory will notify the task manager of sample receipt and will acknowledge receipt of samples on the Chain-of-custody record.

5.2 Sample Documentation and Custody

Standard sample documentation procedures have been established for sampling activities to ensure control of samples during collection, transportation, and storage. The following section addresses the sample documentation and custody procedures for all samples collected during field activities.

Sample documentation during field activities includes the preparation of sample identification and transmittal documents so that sample identification can be maintained and sample location and disposition can be monitored and controlled. The following sample identification and transmittal documents will be used for field activities:

- Sample identification labels
- Custody seals
- Chain-of-custody records
- Transmittal letters
- Field data forms

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5.2.1 Sample Identification Labels

For samples to be submitted to a stationary laboratory, pre-printed adhesive sample identification labels will be secured to the sample containers by the field sampling technician. Adhesive custody seals will be secured to the sample containers and to the outside of shipping containers. Sample documentation forms and labels will be completed using waterproof ink. Sample identification labels will contain the following information:

- Sample location/identifier
- Depth at which sample was collected, where applicable
- Date and time sample was collected
- Analyses to be performed
- Representative volume of air pulled through the stainless steel bottle, vacuum pressure, and length of time exposed, if applicable
- Project number
- Sampler signature
- Preservation method used, where applicable
- Any special instructions to laboratory personnel

Sample custody seals will contain sample location/identifier, sample date, and sampler signature.

5.2.2 Chain-of-Custody Records

Official sample custody will be maintained and documented from the time of sample collection to the presentation of analytical results in the final report. The Chain-of-custody records will document the transfer or shipment of samples from sampling personnel to analytical laboratory personnel and will specify the analyses requested for each sample. The Chain-of-custody records will also serve to cross-reference the project sample identifiers assigned by the task manager with the sample identifiers assigned by the laboratory.

Chain-of-custody records will contain the following information:

- Sample location identifier
- Project code
- Date and time sample was collected
- Project manager and task manager names, telephone numbers, and fax numbers
- Names of sampling personnel
- Shipping method used and date

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- Sample description
- Sample matrix
- Sample volume and number of containers
- Sample destination
- Preservation method used
- Analyses to be performed
- Special handling procedures
- Identity of personnel relinquishing and accepting custody of the samples

Erroneous entries on Chain-of-custody records will be corrected by drawing a line through the error and entering the corrected information. Corrections will be initialed by the individual making them.

5.2.2.1 Field Custody Procedures

The field sampling technician will be responsible for sample care and custody from the time of sample collection until the time of sample transferral or shipment to the laboratory. The field sampling technician will properly seal each sample container with a custody seal. Custody seals will also be placed on shipping containers to ensure sample integrity during shipment to the laboratory. The task manager will determine whether proper custody procedures were followed during field work and will decide if any corrective action is required.

5.2.2.2 Transfer of Custody and Shipment of Samples

Chain-of-custody records will be used to document transfer of sample custody (Table 11). When transferring samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the Chain-of-custody records.

Samples will be properly packaged for shipment in accordance with all U.S. Department of Transportation regulations and will be dispatched to the designated laboratory for analysis with a Chain-of-custody record accompanying each shipment. The method of transport, courier name, and other pertinent information will be entered on the Chain-of-custody record accompanying the samples.

The original Chain-of-custody record will be sent to the laboratory designated on the Chain-of-custody record. Once received at the laboratory, laboratory custody procedures will apply.

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5.2.2.3 *Laboratory Custody Procedures*

A laboratory-designated sample custodian will accept custody of the shipped samples upon receipt at the laboratory and will verify that the field identification numbers on the samples match those on the Chain-of-custody record. The sample custodian will document, on the Chain-of-custody record, the condition of the samples upon receipt and verify that the integrity of the containers has not been compromised. Pertinent information as to shipment, pickup, and courier will be entered in the "Remarks" section of the Chain-of-custody record. It is the laboratory's responsibility to maintain Chain-of-custody records throughout sample preparation and analysis. Additional laboratory-specific custody procedures have been provided (Appendices F and H).

5.2.3 Daily Field Activity Reports and Field Data Forms

A record of sample identification will be maintained on field data forms. Field data forms will be compiled in the field notebook. Additionally, the field notebook will contain copies of the Daily Field Activity Report forms that will include a record of significant events, observations, and measurements made during field investigations, including names of personnel present, site conditions, drilling procedures, sampling procedures, measurement procedures, and calibration records. Field measurements recorded on standardized field data forms will be maintained in the project files (Tables 10, and 12 through 15).

All field data forms will be signed, dated, and kept as a permanent record. Erroneous entries on field data forms will be corrected by drawing a line through the error and entering the correct information. Corrections will be initialed by the individual making them.

5.3 **Quality Control Procedures**

QC procedures have been developed for field activities and laboratory analyses to ensure that samples are collected and analyzed in a manner consistent with the DQOs. Field and laboratory QC procedures have been prepared for field instrument and equipment calibration, sample collection, field parameter measurements, and laboratory analyses (Tables 1 and 3 through 9).

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5.3.1 Calibration Procedures and Frequency

5.3.1.1 *Field Equipment*

Field equipment used to perform various measurements during field activities will include an electric sounder for measuring depths to groundwater; a pH meter for measuring pH; an EC meter for measuring EC; and a field thermometer for measuring temperature of groundwater. Field equipment will be calibrated and used to perform the necessary field measurements in a manner such that data are representative of the actual site conditions. The summary form for field parameter measurements has been provided (Table 12).

Field equipment used during field activities will be maintained, calibrated, and operated according to manufacturer guidelines and recommendations. At a minimum, all field equipment will be inspected and calibrated on receipt from a vendor or from another project office. When in the field, a copy of manufacturer operation and calibration recommendations will accompany the field equipment.

If the calibration of an instrument cannot be easily checked, either test it against another instrument of a similar type or return it to the manufacturer for appropriate calibration on a quarterly basis at the minimum.

A routine schedule and record of field equipment calibration will be maintained throughout field activities (Tables 13 and 14). This will enable the user to document the procedures used in verifying the accuracy of the field equipment.

5.3.1.2 *Analytical Laboratories*

Specific procedures for calibration, operation, and maintenance of laboratory equipment have been described briefly by the laboratories (Appendix E).

5.3.2 Field Measurements

QC procedures will be implemented for field measurements to ensure they are performed and recorded in a manner consistent with the DQOs. In general, the following steps must be implemented as part of the QC procedures for field measurements:

- Document field equipment maintenance and calibration
- Establish written SOPs that are accessible to all field personnel

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- Train personnel in all SOPs relating to their assigned tasks
- Specify professional oversight for various field procedures
- Maintain well-organized, verified, and accessible data files, including original data and field notes
- Perform informal, internal peer auditing of work by field personnel and formal auditing by the task manager or designate through interaction with the project manager

5.3.3 Measure Water Levels

Water levels may be measured using calibrated two-wire electric water level indicators. Field personnel will check to see that the instruments are properly calibrated prior to use, according to the procedures outlined previously. Methods and procedures for water level measurement are detailed in the SOPs (Appendix F).

All sounder probes will be rinsed with distilled water prior to use as described in the SOPs.

5.3.3.1 *Field Parameters*

If sufficient water can be obtained, EC, pH, and temperature will be measured during groundwater sampling. Field personnel will check to see that the instruments are properly calibrated prior to use, according to the procedures outlined in the SOPs. Reference solutions for pH and EC will be prepared and used to properly calibrate the instrument. The EC meter accuracy will be checked prior to use each sampling day. If the EC meter is not within ± 10 percent of the expected value, it will be re-calibrated. The pH meter accuracy will be checked a minimum of one time at the beginning of each sampling day. If the pH meter is not within ± 0.5 pH units of the expected value, it will be re-calibrated.

5.3.4 Sample Collection

QC procedures will be implemented for sample collection to ensure that all soil gas, soil, and groundwater samples are collected in a manner consistent with the DQOs. The task manager will determine the sampling locations and sample identifiers for QC samples, including duplicate samples, field blanks, performance check samples, and, if required, split samples.

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The following QC guidelines apply to sample collection:

- Collect one duplicate groundwater or soil sample for laboratory analysis for every set of 10 or fewer groundwater or soil samples collected per sampling event. The analytical method(s) will be the same as those designated for original samples. The task manager will direct the selection of the locations for duplicate sampling.
- Include one trip blank containing organic-free water for HVOC analysis in each sample shipping container containing groundwater or soil samples that are designated for VOC analysis. Trip blank samples will be prepared by laboratory personnel prior to the beginning of each sampling event.
- Include one field blank for HVOC analysis for every set of 10 or fewer groundwater samples collected per sampling event. The field blank will be prepared by sampling personnel at a predetermined location using organic-free water obtained from the laboratory. The HydroPunch™/BAT. location used for field blanks will be determined by the task manager prior to the groundwater sampling event. The purpose of the field blank is to help identify any possible VOC contamination associated with groundwater sample collection and transport.
- Collect one split groundwater sample for laboratory analysis for every set of 10 or samples collected per sampling event for analysis by the check laboratory. The analytical method(s) will be the same as those designated for original samples. Prepare split samples during groundwater sampling for EPA or other agencies, if required, by alternately filling agency and project groundwater sample containers in sequential order for analysis of each parameter until all containers are filled. Collect one duplicate soil sample for laboratory analysis for every set of 10 or samples collected per sampling event for analysis by the check laboratory. Duplicate soil sampling for EPA or other agencies will be selected and prepared in consultation with the agency's representative.
- Include one equipment rinsate blank for laboratory analysis for every set of 10 or fewer soil samples collected per sampling event for shipment to the laboratory. The rinsate blank will be collected from decontaminated soil sampling equipment using organic-free water obtained from the laboratory. The analytical method(s) will be the same as those designated for original soil samples. The purpose of the rinsate blank is to help identify any possible cross-contamination associated with soil sample collection equipment.

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QC samples will be identified in the same manner as all other samples, when feasible, so that the laboratory will not be aware of their nature as QC samples. Identifiers will be determined by the task manager prior to each sampling event.

5.3.5 Laboratory Analysis

BC Analytical and Del Mar Analytical are the designated stationary analytical laboratories for groundwater and soil sample analyses. HydroGeoChem, Inc. is the designated mobile analytical laboratory for soil gas sample analysis. Individual laboratory QA objectives and procedures have been specified in Appendix D and Appendix E. Analytical summaries containing project-specific QC criteria to be followed by each laboratory for analysis of groundwater are provided in Tables 4 through 9.

5.3.5.1 *Laboratory Facilities*

The individual laboratory QA requirements and procedures are discussed in detail in Appendix D.

5.3.6 Preventive Maintenance

Preventive maintenance includes those activities that must be carried out to minimize downtime of field and laboratory measurement systems. Specific laboratory preventive maintenance measures have been provided by each laboratory (Appendix D and Appendix E). Procedures for preventive maintenance during field sampling and measurement activities include, but are not limited to, the following:

- Calibrate and check field measurement equipment before use.
- Ensure that critical spare parts for instruments are immediately available in case of equipment failure, including electric sounders, extra batteries, buffered solutions, and pH and EC meter probes.
- When practical, ensure that back-up equipment is available. For example, a steel tape can serve as back-up for an electric sounder.
- Identify and review sampling locations and procedures prior to starting field activities each day.

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- Ensure that additional materials for sample collection, including containers, caps, custody seals, and Chain-of-custody records, are available on-site.

5.3.7 Corrective Action

Corrective action will be implemented if it is determined during the data quality assessment and validation process that the field procedures and documentation, analytical procedures, or analytical results are not adequate to achieve the DQOs. Corrective actions that may be implemented include, but are not limited to, the following:

- Altering procedures in the field
- Providing additional training for field personnel
- Using alternative sample containers
- Increasing the frequency of calibration or maintenance for field measurement instruments
- Re-sampling or reanalyzing samples
- Contacting the laboratory to initiate specific internal corrective actions
- Auditing laboratory procedures

The project manager or task manager will be responsible for initiating corrective action for all field activities. The task manager will also be responsible for ensuring that corrective actions for laboratory activities are initiated and that corrective actions implemented are adequate to meet DQOs.

Should field measurement data or analytical results indicate inconsistencies resulting from field procedures, field corrective actions will be implemented as follows:

- The pH meter will be re-calibrated if periodic pH buffered solution readings vary by more than ± 0.5 pH units from the pH of the original buffered solution used to calibrate the probe. The integrity of the pH probe and possible degradation of the pH buffered solutions will also be evaluated.
- The EC meter will be re-calibrated if periodic checks of its calibration indicate that EC readings vary by more than 10 percent from the concentration of the calibration standard. The integrity of the EC probe and possible degradation of the EC standard solutions will also be evaluated.
- Thermometers will be checked against reference thermometers prior to field activities. Thermometers that vary by more than 0.5 degrees Celsius ($^{\circ}\text{C}$) from the

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readings of the reference thermometers will be discarded or recertified by a National Institute of Standards and Testing calibration source.

- Sampling and decontamination procedures will be reviewed if compounds of concern or other chemicals are detected in field blanks or trip blanks in concentrations exceeding RDLs or documented laboratory contaminant levels.
- Sampling and decontamination procedures will be reviewed if analytical results of field duplicate or split samples indicate poor precision.

Laboratory corrective actions will be initiated if analytical results are not provided in a timely manner or are determined to contain inconsistencies during the data quality assessment and validation processes. The laboratory will be contacted to discuss corrective action for specific inconsistencies.

At a minimum, the laboratory will adhere to corrective action procedures outlined in Title 40, Code of Federal Regulations, Section 136 or as outlined by EPA (EPA, 1992).

5.4 Data Assessment

Chemical quality data for samples analyzed using various EPA methods will be reviewed during data assessment activities to assess the quality of the data against the predetermined data quality objectives established for the specific field sampling activity. This procedure has been established to ensure that data assessment validation activities are performed in a consistent manner.

Data assessment validation differs from typical data validation in the comprehensiveness of the analytical package provided by the laboratory for review, the degree to which raw analytical data from the analytical laboratory are scrutinized, and the exclusion of site hydrogeologic data and historical trends during data evaluation. Data assessment procedures will be performed on all analytical data collected as part of routine project activities.

5.4.1 Data Assessment Procedures

Data assessment procedures include evaluation of the following categories of support documentation associated with analytical data:

- Sample holding times

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- ▶ Preservation procedures
- ▶ Analytical methods and data reporting
- ▶ Field blanks, trip blanks, and laboratory reagent blanks
- ▶ Matrix spike recovery
- ▶ Matrix spike duplicate analysis
- ▶ Field duplicate analysis
- ▶ Split sample analysis

Standard procedures will be used to perform routine data assessment of chemical quality data reported by the laboratory and to assign England/Hargis data qualifiers (Table 16). Data qualifiers were developed to differentiate data qualified by England/Hargis through data assessment procedures from data qualified through data validation performed by England/Hargis and/or EPA.

Data assessment will be performed using hard copy laboratory reports. After data assessment activities have been completed, a memorandum summarizing the results will be prepared.

5.4.1.1 Holding Times

A comparison will be made between the sampling date and the date of laboratory analysis for each sample submitted to the laboratory. The analytical results, including less than detection limit results, for samples identified as exceeding the required holding time will be qualified with "E" and will be documented in the summary memorandum.

5.4.1.2 Analytical Methods and Data Reporting

The laboratory report will be checked against the sample Chain-of-custody record to verify that appropriate analytical results were reported for all samples submitted and that the analytical methods requested in sample documentation were used by the laboratory. Instances of requested analyses not included in the laboratory report, due to occurrences such as breakage in the laboratory, misidentification of samples, missing or incomplete analyses, or use of incorrect analytical methods, will be documented in the summary memorandum.

5.4.1.3 Field Blanks, Trip Blanks, and Laboratory Reagent Blanks

The hard copy laboratory reports will be reviewed to determine whether any analytes were detected in any of the field blanks, trip blanks, or laboratory reagent blanks associated with

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the sampling event and analysis procedures. The results of the data search will be documented in the summary memorandum. If an analyte is detected in a blank sample, the following procedures will be performed to identify data subject to qualification:

- Compile a list of a blank samples in which analytes were detected including method of analysis, analyte concentration, batch number of water used to prepare the blank, if available, dates of blank sample collection and analysis, and specific laboratory instrument used for blank sample analysis, if applicable.
- For analyte detections in field or trip blanks, review the hard copy laboratory reports for all groundwater samples in which the analyte was detected that were listed on the same Chain-of-custody record as the blank sample. Review laboratory reports and identify all detections of the analyte in groundwater samples that were analyzed using the same laboratory instrument, if known, on the same date of sample analysis, using the same analytical method. Compile a list of identified groundwater sample analytical results for qualification.
- For analyte detections in laboratory reagent blanks, review analytical reports and identify all detections of the analyte in groundwater samples that were analyzed on the same laboratory instrument, if known, on the same date of sample analysis, using the same analytical method. Compile a list of identified groundwater sample analytical results for qualification.
- Assign data qualifiers to the compiled list(s) of results as follows:
 - If the concentration of the analyte in the groundwater sample is less than or equal to the concentration in the associated blank, qualify the data with a "U".
 - If the concentration of the analyte in the groundwater sample is greater than the concentration in the associated blank but is less than or equal to five times the blank concentration, qualify the data with an "E".
 - If the concentration of the analyte in the groundwater sample is greater than five times the blank concentration, the data is acceptable and will be qualified with an "S".
- Document the review of blank samples and list data qualified in the summary memorandum.

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5.4.1.4 *Matrix Spike Recovery*

Matrix spike recovery data in the laboratory report will be compared with the acceptable range of percent recovery for each analyte, as specified in the applicable QAP and/or LSA letter for the project. If a matrix spike recovery percentage is less than the minimum acceptable percent recovery, the following procedures will be used to identify data subject to qualification:

- Compile a list of analyte matrix spike recoveries that are less than the minimum acceptable percent recovery, along with sample identifiers and date of spike sample analysis.
- Review the analytical reports to identify all groundwater samples analyzed for the same analyte, for the same analytical method, and on the same date of matrix spike analysis. Compile a list of identified analytical results for qualification, including all less than detection limit results.
- Assign the data qualifier "E" to all analytical results on the compiled list.
- Document the review of matrix spike recovery data and list data qualified in the summary memorandum.

If a matrix spike percent recovery is greater than the maximum acceptable percent recovery, the following procedures will be used to identify data subject to qualifications:

- Compile a list of matrix spike recovery values that are greater than the maximum acceptable percent recovery, along with sample identifiers and date of spike sample analysis.
- Review the analytical reports to identify all groundwater samples analyzed for the same analyte for the same analytical method and on the same date of matrix spike analysis. Compile a list of identified analytical results for qualifications. Do not include less than detection limit results.
- Assign the data qualifier "E" to all analytical results on the compiled list.
- Document the review of matrix spike recovery data and list data qualifiers in the summary memorandum for the data assessment.

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5.4.1.5 *Matrix Spike Duplicates*

Matrix spike duplicate data in the laboratory report will be compared against the acceptable RPDs specified in the applicable QAP and/or LSA for the project. If a matrix spike duplicate analysis for an analyte exceeds the acceptable RPD for the analyte, the following procedures will be used to identify data subject to qualification:

- Compile a list of analytes for which matrix spike duplicate RPDs are greater than the acceptable RPD for that analyte, including sample identifier of the matrix spike duplicate sample and date of matrix spike duplicate analysis.
- Review the analytical reports to identify all groundwater samples analyzed for the same analyte, using the same method, on the same date of matrix spike duplicate analysis. Compile a list of identified analytical results for qualification, including less than detection limit results.
- Assign the data qualifier "E" to all analytical results on the compiled list.
- Document the review of matrix spike duplicate analyses and list data qualified in the summary memorandum.

5.4.1.6 *Field Duplicates*

The analytical results for field duplicate samples will be tabulated and RPDs for each analyte will be computed. Instances in which an analyte was not detected in both samples will be identified. Instances in which an analyte was detected in only one sample and not in its duplicate sample will also be identified and an approximate RPD will be calculated by substituting the analytical detection limit for the less than detection limit result in the RPD formula. If field duplicate analysis for an analyte exceeds the acceptable RPD for the analyte, the concentrations of the analyte detected in the original and associated duplicate samples are subject to further review based on additional data for the site.

Based on the outcome of this review, the data qualifiers "E" or "U" may be assigned to the original and/or the duplicate analytical result for the analyte. The results of the duplicate sample review, including rationale for assigning data qualifiers, along with the list of data qualified with England/Hargis qualifiers other than "S" will be included in the summary memorandum.

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5.4.1.7 *Split Samples*

The analytical results for split samples will be tabulated and RPDs for each analyte will be computed. Instances in which an analyte was not detected in both samples will be identified. Instances in which an analyte was detected in only one sample and not in its split sample will also be identified and an approximate RPD calculated by substituting the analytical detection limit for the less than detection limit result in the RPD formula. The calculated RPDs will be compared to the historical RPDs compiled for split samples for the project. If split sample analysis for an analyte exceeds the acceptable RPD for the analyte, the concentrations of the analyte detected in the original and associated split samples will be subject to further review based on additional data for the site. Based on the outcome of this review, the data qualifiers "E" or "U" may be assigned to the original and/or the split analytical result for the analyte. The results of the split sample review, including rationale for assigning data qualifiers and the list of data qualified, will be included in the summary memorandum.

5.4.2 Corrective Action

Corrective actions may be required at any point in the data assessment or data validation process. Problems with laboratory or field quality control data or analytical results should be relayed as soon as possible by England/Hargis to the laboratory manager. The laboratory will be instructed to check raw data and computations, as necessary, to identify any problems due to data transposition, reported units of measurement, or calculation errors. The laboratory may be instructed to re-run a partial sample if sample holding time limits have not been exceeded. The laboratory will issue an amended hard-copy analytical report if any previously reported data are found to be in error. If major quality control problems are identified during data validation or data assessment procedures, the task manager may request that additional samples be collected from a sample location for laboratory analysis.

5.4.3 Reporting

The task manager will review the list of all data to be qualified and approve data qualifiers. Analytical results found to be satisfactory based on the data assessment process will be qualified with an "S". England/Hargis data qualifiers, excluding those data qualified with an "S," will appear in tables summarizing the results of water quality analyses.

EPA data qualifiers, with the exception of "U," will appear in tables summarizing the results of water quality analyses. England/Hargis uses a less than sign, (<), to indicate that an analyte was not detected and, therefore, use of EPA's "U" qualifier is not required.

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Data with England/Hargis "E" or EPA "J" qualifiers may be used for general site characterization purposes. These data will not be used for site decision-making purposes, such as determining the presence or absence of contaminants, determining the effectiveness of remedial actions, assessing the clean-up status of an aquifer, or assessing the attainment of clean-up goals in an aquifer. Data with England/Hargis "U" or EPA "R" qualifiers will not be used for either site characterization or site decision-making purposes.

Tables

Table 1

HANDLING PROTOCOL FOR GROUNDWATER AND SOIL SAMPLES

<u>ANALYTE</u>	<u>SAMPLE CONTAINER</u>	<u>SAMPLE VOLUME</u>	<u>PRESERVATION METHOD</u>	<u>MAXIMUM HOLDING TIME</u>
GROUNDWATER SAMPLES				
<u>Organic Compounds</u>				
Volatile Organic Compounds (EPA Methods 624/8240, 601/8010)	Two 40-ml glass vials, teflon-lined septum	Vials filled completely, no head space	HCl to pH <2 Cool to 4°C	14 days
Semivolatile Organic Compounds (EPA Method 625/8270)	Two 1-liter amber glass bottles	Bottle filled to neck	Cool to 4°C	7 days until extraction, 40 days after extraction
SOIL AND NEAR-SURFACE MATERIAL SAMPLES				
<u>Organic Compounds</u>				
Volatile Organic Compounds (EPA Methods 8010 and 8240)	Brass sample tube sleeve with teflon-lined end caps	2-inch diameter, 6-inch length	Cool to 4°C	14 days
Semivolatile Organic Compounds (EPA Method 8270)	Brass sample tube sleeve with teflon-lined end caps	2-inch diameter, 6-inch length	Cool to 4°C	14 days until extraction, 40 days until analysis

Note: Refer to page 2 of this table for footnotes.

Table 1 (Cont.)
**HANDLING PROTOCOL FOR
GROUNDWATER AND SOIL SAMPLES**
PAGE 2 of 2

<u>ANALYTE</u>	<u>SAMPLE CONTAINER</u>	<u>SAMPLE VOLUME</u>	<u>PRESERVATION METHOD</u>	<u>MAXIMUM HOLDING TIME</u>
SOIL AND NEAR-SURFACE MATERIAL SAMPLES (Cont.)				
<u>Organic Compounds</u>				
Chlorinated Pesticides (EPA Method 608/8080)	Brass sample tube sleeve with teflon-lined end caps	2-inch diameter, 6-inch length	Cool to 4°C	14 days until extraction, 40 days until analysis
<u>Inorganic Compounds</u>				
CCR Metals	Brass sample tube sleeve with teflon-lined end caps	2-inch diameter, 6-inch length	Cool to 4°C	6 months

Footnotes:

EPA	=	U.S. Environmental Protection Agency
ml	=	Milliliters
HCl	=	Hydrochloric acid
(<)	=	Less than
°C	=	Degrees Celsius
CCR	=	California Code of Regulations, Title 22

Table 2

MAJOR DATA USE CATEGORIES

<u>SOURCE OF DATA</u>	<u>INTENDED USE OF DATA</u>
Shallow Soil Gas Survey	Determine the horizontal extent of soil contamination by halogenated VOCs, evaluate optimum locations for shallow soil sampling and depth-specific groundwater sampling, and further define potential source areas.
Sampling of "Grossly Contaminated" Soil, Concrete, and Asphalt	Determine the type of compounds historically stored and handled at the site, better define former chemical storage areas, and evaluate optimum locations for shallow soil sampling.
Shallow Soil Sampling	Evaluate the nature and extent of shallow soil contamination, further define potential source areas, and evaluate optimum locations for depth-specific groundwater sampling.
Location, Rehabilitation, and Sampling of Existing Well BMW-1	Evaluate the current condition of the well and casing, characterize the aquifer beneath the site, and characterize the distribution of VOC concentrations in groundwater beneath the site.
Review Regional Hydrogeologic Data	Characterize the geologic setting and hydrogeologic conditions beneath the site vicinity, estimate flow directions and chemical quality of groundwater, and identify known and potential sources of groundwater contamination in the vicinity of the site.
Cone Penetrometer Test Investigation and HydroPunch™/BAT® Sampling	Provide data to assess the chemical quality of groundwater beneath the site, characterize the lateral and vertical distribution of VOC concentrations in groundwater, and further define potential source areas.

Table 3

FIELD PROCEDURES AND QUALITY ASSURANCE OBJECTIVES

PROCEDURE	EQUIPMENT CHECK AND/OR CALIBRATION	OPERATIONAL PROCEDURE	PERSONNEL	DATA STORAGE SYSTEM	PRECISION	ACCURACY
Lithologic Logging	NA	SOP	Hydrogeologist	Hard copy	NA	NA
Hydraulic Testing	Slug, watches/chronometers, electric water level sounder, steel tape	SOP	Hydrogeologist, field technician	Hard copy	NA	NA
Well Discharge	Container/stopwatch, in-line flow meter	SOP	Hydrogeologist, field technician	Hard copy	5 percent of the discharge rate	±10 percent
Water Level Elevation Measurement	Electric water level sounder, steel tape	SOP and manufacturer instructions for equipment	Field technician	Hard copy	0.01 foot	±0.1 foot
Water Sample Collection (excludes determination of electrical conductivity, pH, and temperature)	Pumps, sample bottles, shipping containers, transmittal forms, chain-of-custody records, field forms	SOP	Hydrogeologist, field technician	Hard copy	NA	NA
Electrical Conductivity	Conductivity meter, field form	SOP and manufacturer instructions for equipment	Hydrogeologist, field technician	Hard copy	±5 umhos when scale units are x1	±10 umhos when scale units are x1
pH	pH meter, field form	SOP and manufacturer instructions for equipment	Hydrogeologist, field technician	Hard copy	±0.05 unit	0.5 unit

Notes: SOP = Standard operating procedure
 NA = Not applicable
 (±) = Plus or minus
 umhos = Micromhos
 °C = Degrees Celsius

Table 3 (Cont.)
**FIELD PROCEDURES AND
 QUALITY ASSURANCE OBJECTIVES**
 Page 2 of 2

PROCEDURE	EQUIPMENT CHECK AND/OR CALIBRATION	OPERATIONAL PROCEDURE	PERSONNEL	DATA STORAGE SYSTEM	PRECISION	ACCURACY
Temperature	Field thermometer, field form	SOP	Hydrogeologist, field technician	Hard copy	$\pm 0.1^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$
Depth-specific Groundwater Sample Collection	Sample bottles, shipping containers, transmittal forms, chain-of-custody records, field forms	SOP	Hydrogeologist	Hard copy	NA	NA
Near-surface Material and Soil Sample Collection	Hand trowels and augers, split-spoon sampler, single tube sampler, sample sleeves, shipping containers, transmittal forms, chain-of-custody records, field forms	SOP	Hydrogeologist, field technician	Hard copy	NA	NA

Notes: SOP = Standard operating procedure
 NA = Not applicable
 (\pm) = Plus or minus
 umhos = Micromhos
 $^{\circ}\text{C}$ = Degrees Celsius

Table 4

ANALYTICAL METHODS, DETECTION LIMITS, AND QUALITY CONTROL CRITERIA FOR ORGANIC COMPOUNDS IN SOIL AND WATER SAMPLES

ORGANIC COMPOUNDS	REPORTING ...DETECTION LIMITS...		INTRALABORATORYPRECISION(a).....	ACCURACY.....	
	WATER (ug/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)	WATER (percent)	SOIL (percent)
<i>EPA Method 8240</i>						
Chloromethane	1	0.005	---	---	---	---
Bromomethane	1	0.005	---	---	---	---
Vinyl chloride	1	0.005	---	---	---	---
Chloroethane	1	0.005	---	---	---	---
Methylene chloride	1	0.005	---	---	---	---
Acetone	20	0.1	---	---	---	---
Carbon disulfide	2	0.01	---	---	---	---
1,1-Dichloroethylene	1	0.005	27	28	48 - 127	41 - 148
1,1-Dichloroethane	1	0.005	---	---	---	---
Chloroform	1	0.005	---	---	---	---
1,2-Dichloroethane	1	0.005	---	---	---	---
2-Butanone (MEK)	5	0.03	---	---	---	---
1,1,1-Trichloroethane	1	0.005	---	---	---	---
Carbon tetrachloride	1	0.005	---	---	---	---
Bromodichloromethane	1	0.005	---	---	---	---
1,1,2,2-Tetrachloroethane	1	0.005	---	---	---	---
1,2-Dichloropropane	1	0.005	---	---	---	---
cis-1,3-Dichloropropylene	1	0.005	---	---	---	---
Trichloroethylene	1	0.005	21	29	63 - 122	53 - 135
Dibromochloromethane	1	0.005	---	---	---	---
1,1,2-Trichloroethane	1	0.005	---	---	---	---
Benzene	1	0.005	26	25	65 - 125	59 - 134
trans-1,3-Dichloropropylene	1	0.005	---	---	---	---
Bromoform	1	0.005	---	---	---	---
2-Hexanone	5	0.03	---	---	---	---
4-Methyl-2-pentanone	5	0.03	---	---	---	---
Tetrachloroethylene	1	0.005	---	---	---	---
Toluene	1	0.005	22	19	63 - 132	57 - 139
Chlorobenzene	1	0.005	23	19	76 - 132	58 - 148
Ethyl benzene	1	0.005	---	---	---	---
Styrene	1	0.005	---	---	---	---
Xylenes (total)	1	0.02	---	---	---	---
cis-1,2-Dichloroethylene	1	0.005	---	---	---	---
trans-1,2-Dichloroethylene	1	0.005	---	---	---	---
1,2-Dichlorobenzene	1	0.005	---	---	---	---
1,3-Dichlorobenzene	1	0.005	---	---	---	---
1,4-Dichlorobenzene	1	0.005	---	---	---	---
(Freon 11) Trichlorofluoromethane	1	0.005	---	---	---	---
(Freon 113) Trichlorotrifluoroethane	2	0.01	---	---	---	---

Notes: (a) Relative percent difference
 ug/l = Micrograms per liter
 mg/kg = Milligrams per kilogram
 EPA = U.S. Environmental Protection Agency
 MEK = Methyl ethyl ketone
 PCB = Polychlorinated biphenyl

Table 4 (Cont.)
ANALYTICAL METHODS, DETECTION LIMITS,
AND QUALITY CONTROL CRITERIA FOR ORGANIC
COMPOUNDS IN SOIL AND WATER SAMPLES
Page 2 of 5

ORGANIC COMPOUNDS	REPORTING ...DETECTION LIMITS...		INTRALABORATORYPRECISION(a).....	ACCURACY.....	
	WATER (ug/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)	WATER (percent)	SOIL (percent)
<i>EPA Method 8270</i>						
Phenol	5	0.2	---	---	---	---
bis (2-Chloroethyl) ether	5	0.2	---	---	---	---
2-Chlorophenol	5	0.2	24	29	43 - 110	45 - 110
1,3-Dichlorobenzene	5	0.2	---	---	---	---
1,4-Dichlorobenzene	5	0.2	34	37	39 - 110	20 - 124
Benzyl alcohol	5	0.2	---	---	---	---
1,2-Dichlorobenzene	6	0.2	---	---	---	---
2-Methylphenol	8	0.2	---	---	---	---
bis (2-Chloroisopropyl) ether	6	0.2	---	---	---	---
4-Methylphenol	5	0.3	---	---	---	---
N-Nitroso-dipropylamine	6	0.2	25	26	33 - 135	29 - 149
Hexachloroethane	5	0.2	---	---	---	---
Nitrobenzene	5	0.2	---	---	---	---
Isophorone	5	0.2	---	---	---	---
2-Nitrophenol	5	0.2	---	---	---	---
2,4-Dimethylphenol	5	0.2	---	---	---	---
Benzoic acid	50	2	---	---	---	---
Acenaphthene	5	0.2	26	42	52 - 131	1 - 191
2,4-Dinitrophenol	10	0.4	---	---	---	---
4-Nitrophenol	5	0.2	34	46	1 - 132	19 - 132
Dibenzofuran	5	0.2	---	---	---	---
2,4-Dinitrotoluene	5	0.2	25	36	48 - 139	39 - 139
2,6-Dinitrotoluene	5	0.2	---	---	---	---
Diethylphthalate	5	0.2	---	---	---	---
4-Chlorophenyl phenyl ether	5	0.2	---	---	---	---
Fluorene	5	0.2	---	---	---	---
4-Nitroaniline	5	0.2	---	---	---	---
4,6-Dinitro-2-methylphenol	5	0.2	---	---	---	---
N-nitrosodiphenylamine	5	0.2	---	---	---	---
4-Bromophenyl phenyl ether	5	0.2	---	---	---	---
Hexachlorobenzene	5	0.2	---	---	---	---
Pentachlorophenol	5	0.2	39	47	14 - 176	20 - 165
Phenanthrene	5	0.2	---	---	---	---
Anthracene	5	0.2	---	---	---	---

Notes: (a) Relative percent difference
ug/l = Micrograms per liter
mg/kg = Milligrams per kilogram
EPA = U.S. Environmental Protection Agency
MEK = Methyl ethyl ketone
PCB = Polychlorinated biphenyl

Table 4 (Cont.)

ANALYTICAL METHODS, DETECTION LIMITS,
AND QUALITY CONTROL CRITERIA FOR ORGANIC
COMPOUNDS IN SOIL AND WATER SAMPLES

Page 3 of 5

ORGANIC COMPOUNDS	REPORTING ...DETECTION LIMITS...		INTRALABORATORYPRECISION(a).....	ACCURACY.....	
	WATER (ug/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)	WATER (percent)	SOIL (percent)
<i>EPA Method 8270 (Cont.)</i>						
N-nitrosodimethylamine	6	0.2	---	---	---	---
bis (2-Chloroethoxy) methane	5	0.2	---	---	---	---
2,4-Dichlorophenol	5	0.2	---	---	---	---
1,2,4-Trichlorobenzene	5	0.2	39	36	44 - 120	44 - 115
Naphthalene	5	0.2	---	---	---	---
4-Chloroaniline	5	0.2	---	---	---	---
Hexachlorobutadiene	5	0.2	---	---	---	---
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	5	0.2	31	32	48 - 127	40 - 137
2-Methylnaphthalene	5	0.2	---	---	---	---
Hexachlorocyclopentadiene	5	0.2	---	---	---	---
2,4,6-Trichlorophenol	5	0.2	---	---	---	---
2,4,5-Trichlorophenol	6	0.2	---	---	---	---
2-Chloronaphthalene	6	0.2	---	---	---	---
2-Nitroaniline	5	0.2	---	---	---	---
Dimethyl phthalate	5	0.2	---	---	---	---
Acenaphthylene	5	0.2	---	---	---	---
3-Nitroaniline	5	0.2	---	---	---	---
Di-n-butyl phthalate	5	0.2	---	---	---	---
Fluoranthene	5	0.2	---	---	---	---
Pyrene	5	0.2	34	36	45 - 162	52 - 115
Butyl benzyl phthalate	5	0.2	---	---	---	---
3,3'-Dichlorobenzidine	20	0.7	---	---	---	---
Benzo(a)anthracene	5	0.2	---	---	---	---
Chrysene	5	0.2	---	---	---	---
bis (2-Ethylhexyl) phthalate	7	0.3	---	---	---	---
Di-n-octyl phthalate	6	0.2	---	---	---	---
Benzo(b)fluoranthene	6	0.2	---	---	---	---
Benzo(k)fluoranthene	6	0.2	---	---	---	---
Benzo(a)pyrene	6	0.2	---	---	---	---
Indeno(1,2,3-cd)pyrene	7	0.3	---	---	---	---
Dibenz(a,h)anthracene	5	0.2	---	---	---	---
Benzo(g,h,i)perylene	5	0.2	---	---	---	---

Notes: (a) Relative percent difference
 ug/l = Micrograms per liter
 mg/kg = Milligrams per kilogram
 EPA = U.S. Environmental Protection Agency
 MEK = Methyl ethyl ketone
 PCB = Polychlorinated biphenyl

Table 4 (Cont.)
ANALYTICAL METHODS, DETECTION LIMITS,
AND QUALITY CONTROL CRITERIA FOR ORGANIC
COMPOUNDS IN SOIL AND WATER SAMPLES
Page 4 of 5

ORGANIC COMPOUNDS	REPORTING ...DETECTION LIMITS...		INTRALABORATORYPRECISION(a).....	ACCURACY.....	
	WATER (ug/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)	WATER (percent)	SOIL (percent)
<i>EPA Method 8080</i>						
PCB-1016	1.0	0.03	---	---	---	---
PCB-1221	1.0	0.03	---	---	---	---
PCB-1232	1.0	0.03	---	---	---	---
PCB-1242	1.0	0.03	---	---	---	---
PCB-1248	1.0	0.03	---	---	---	---
PCB-1254	1.0	0.03	---	---	---	---
PCB-1260	1.0	0.03	22	55	40 - 130	43 - 123
Aldrin	0.02	0.0007	41	24	42 - 122	42 - 122
Chlordane	0.4	0.02	---	---	---	---
p,p'-DDD	0.02	0.0007	---	---	---	---
p,p'-DDE	0.02	0.0007	---	---	---	---
p,p'-DDT	0.02	0.0007	33	24	40 - 131	25 - 160
Dieldrin	0.02	0.0007	37	37	41 - 143	36 - 146
Endosulfan I	0.02	0.0007	---	---	---	---
Endosulfan II	0.02	0.0007	---	---	---	---
Endosulfan sulfate	0.1	0.004	---	---	---	---
Endrin	0.02	0.0007	39	43	33 - 147	30 - 147
Endrin aldehyde	0.02	0.0007	---	---	---	---
Heptachlor epoxide	0.02	0.0007	---	---	---	---
Heptachlor	0.01	0.0004	35	52	34 - 141	40 - 148
Methoxychlor	0.03	0.001	---	---	---	---
Toxaphene	0.5	0.02	---	---	---	---
BHC, alpha isomer	0.01	0.0004	---	---	---	---
BHC, beta isomer	0.02	0.0007	---	---	---	---
BHC, delta isomer	0.02	0.0007	---	---	---	---
BHC, gamma isomer (Lindane)	0.01	0.0004	30	32	32 - 127	32 - 127

Notes: (a) Relative percent difference
ug/l = Micrograms per liter
mg/kg = Milligrams per kilogram
EPA = U.S. Environmental Protection Agency
MEK = Methyl ethyl ketone
PCB = Polychlorinated biphenyl

Table 4 (Cont.)
**ANALYTICAL METHODS, DETECTION LIMITS,
AND QUALITY CONTROL CRITERIA FOR ORGANIC
COMPOUNDS IN SOIL AND WATER SAMPLES**
Page 5 of 5

ORGANIC COMPOUNDS	REPORTING ...DETECTION LIMITS...		INTRALABORATORYPRECISION(a).....	ACCURACY.....	
	WATER (ug/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)	WATER (percent)	SOIL (percent)
<i>EPA Method 8010</i>						
1,1,1-Trichloroethane	0.5	0.005	---	---	---	---
1,1,2,2-Tetrachloroethane	0.5	0.005	---	---	---	---
1,1,2-Trichloroethane	0.5	0.005	---	---	---	---
1,1-Dichloroethane	0.5	0.005	---	---	---	---
1,1-Dichloroethene	0.5	0.005	27	26	50 - 147	57 - 176
1,2-Dichloroethane	0.5	0.005	---	---	---	---
1,2-Dichlorobenzene	0.5	0.005	---	---	---	---
1,2-Dichloropropane	0.5	0.005	---	---	---	---
1,3-Dichlorobenzene	0.5	0.005	---	---	---	---
1,4-Dichlorobenzene	0.5	0.005	---	---	---	---
Bromodichloromethane	0.5	0.005	---	---	---	---
Bromomethane	0.5	0.005	---	---	---	---
Bromoform	0.5	0.005	---	---	---	---
Chlorobenzene	0.5	0.005	19	21	61 - 139	76 - 145
Carbon Tetrachloride	0.5	0.005	---	---	---	---
Chloroethane	0.5	0.005	---	---	---	---
Chloroform	0.5	0.005	---	---	---	---
Chloromethane	0.5	0.005	---	---	---	---
Dibromochloromethane	0.5	0.005	---	---	---	---
Freon 113	0.5	0.005	---	---	---	---
Methylene chloride	0.5	0.005	---	---	---	---
Trichloroethene	0.5	0.005	43	37	52 - 162	71 - 182
Trichlorofluoromethane	0.5	0.005	---	---	---	---
Tetrachloroethene	0.5	0.005	---	---	---	---
Vinyl chloride	0.5	0.005	---	---	---	---
cis-1,2-Dichloroethene	0.5	0.005	---	---	---	---
cis-1,3-Dichloropropane	0.5	0.005	---	---	---	---
trans-1,2-Dichloroethene	0.5	0.005	---	---	---	---
trans-1,3-Dichloropropane	0.5	0.005	---	---	---	---
Bromochloromethane Reported	0.5	0.005	---	---	---	---

Notes: (a) Relative percent difference
ug/l = Micrograms per liter
mg/kg = Milligrams per kilogram
EPA = U.S. Environmental Protection Agency
MEK = Methyl ethyl ketone
PCB = Polychlorinated biphenyl

Table 5

**ANALYTICAL METHODS, DETECTION LIMITS, AND QUALITY CONTROL CRITERIA
FOR INORGANIC CONSTITUENTS IN SOIL AND GROUNDWATER SAMPLES**

INORGANIC CONSTITUENTS	SAMPLE PREPARATION METHOD NUMBER(a)(c)	ANALYTICAL METHOD NUMBER(a)	REPORTING DETECTION LIMITS		INTRALABORATORY PRECISION(b)	ACCURACY.....	
			WATER (mg/l)	SOIL (mg/kg)	WATER (mg/l)	SOIL (mg/kg)	WATER (percent)	SOIL (percent)
METALS								
CCR Metals								
Antimony	3010 - 3050	6010	0.1	10.0	20	30	83 - 112	5 - 118
Arsenic	3020 - 3050	7060	0.002	0.2	20	30	52 - 117	18 - 167
Barium	3010 - 3050	6010	0.005	0.5	20	30	74 - 110	63 - 129
Beryllium	3010 - 3050	6010	0.001	0.1	20	30	71 - 113	68 - 131
Cadmium	3010 - 3050	6010	0.005	0.5	20	30	69 - 111	55 - 125
Chromium (total)	3010 - 3050	6010	0.01	1.0	20	30	68 - 111	40 - 137
Cobalt	3010 - 3050	6010	0.04	4.0	20	30	67 - 110	59 - 117
Copper	3010 - 3050	6010	0.02	2.0	20	30	68 - 110	54 - 122
Lead	3020 - 3050	7421	0.002	0.2	20	30	54 - 144	31 - 159
Mercury	---	7470	0.0002	0.1	20	30	53 - 143	65 - 136
Molybdenum	3010 - 3050	6010	0.01	1.0	20	30	71 - 110	59 - 114
Nickel	3010 - 3050	6010	0.04	1.0	20	30	65 - 113	52 - 126
Selenium	3020 - 3050	7740	0.004	0.2	20	30	4 - 140	4 - 148
Silver	3010 - 3050	6010	0.01	1.0	20	30	74 - 112	51 - 127
Thallium	3020 - 3050	7841	0.002	0.3	20	30	42 - 124	5 - 142
Vanadium	3010 - 3050	6010	0.04	4.0	20	30	72 - 110	67 - 115
Zinc	3010 - 3050	6010	0.01	1.0	20	30	61 - 121	43 - 142
Chromium (hexavalent)	---	7196	0.01	0.2	20	30	85 - 115	85 - 115

Footnotes

- (a) EPA, 1992.
 (b) Relative percent difference, as percent.
 (c) Sample Preparation Digest Method 3010 is for water analysis EPA Method 6010.
 Sample Preparation Digest Method 3020 is for water analysis EPA 7000 Series.
 Sample Preparation Method 3050 is for soil analysis EPA Methods 6010 and 7000 Series.

mg/l = Milligrams per liter.
 mg/kg = Milligrams per kilogram.
 CCR = California Code of Regulations, Title 22.
 (---) = Sample preparation methods are described in the analytical method.

Table 6

ACCEPTANCE CRITERIA FOR INSTRUMENT CALIBRATION

METHOD	ACCEPTANCE CRITERIA	
	Initial Calibration	Continuing Calibration
EPA 601/8010	Percent RSD \leq 25 percent	Percent D \leq 25 percent
EPA 624/8240	RRF \geq 0.30 (0.25 for bromoform) for SPCCs and percent RSD \leq 30 percent for CCCs	RRF \geq 0.30 (0.25 for bromoform) for SPCCs and percent D \leq 30 percent for CCCs
EPA 625/8270	RRF \geq 0.05 for SPCCs and percent RSD \leq 30 percent for CCCs	RRF \geq 0.05 for SPCCs and percent D \leq 30 percent for CCCs
EPA 608/8080	Correlation coefficient \geq 0.995	Percent D \leq 15 percent
EPA 6010	Percent D \leq 10 percent or correlation coefficient \geq 0.995	Percent D \leq 10 percent
EPA 7000	Correlation coefficient \geq 0.995	Percent D \leq 10 percent
EPA 100 and 300 Series Methods	Correlation coefficient \geq 0.995(a)	Percent D \leq 15 percent

Notes: (a) As applicable to each method
 EPA = U.S. Environmental Protection Agency
 RRF = Average Relative Response Factor
 \geq = Greater or equal to
 SPCCs = System Performance Check Compounds
 RSD = Relative Standard Deviation
 \leq = Less than or equal to
 CCCs = Calibration Check Compounds
 D = Difference

Table 7

**CALIBRATION CHECK COMPOUNDS AND
SYSTEM PERFORMANCE CHECK COMPOUNDS
WITH ACCEPTANCE CRITERIA FOR ORGANIC ANALYSES**

METHOD/COMPOUND	ACCEPTANCE CRITERIA
<i>EPA METHOD 8240</i>	
<u>SPCC</u>	<u>Minimum $\overline{\text{RRF}}$</u>
Chloromethane	0.300
1,1-Dichloroethane	0.300
Bromoform	0.250
1,1,2,2-Tetrachloroethane	0.300
Chlorobenzene	0.300
<u>CCC</u>	<u>MAXIMUM PERCENT RSD</u>
Vinyl Chloride	30.0
1,1-Dichloroethylene	30.0
Chloroform	30.0
1,2-Dichloropropane	30.0
Toluene	30.0
Ethylbenzene	30.0
<i>EPA METHOD 8270</i>	
<u>SPCC</u>	<u>MINIMUM $\overline{\text{RRF}}$</u>
N-Nitroso-di-n-propylamine	0.050
Hexachlorocyclopentadiene	0.050
2,4-Dinitrophenol	0.050
4-Nitrophenol	0.050
<u>CCC</u>	<u>MAXIMUM PERCENT RSD</u>
Phenol	30.0
1,4-Dichlorobenzene	30.0
2-Nitrophenol	30.0
2,4-Dichlorophenol	30.0
Hexachlorobutadiene	30.0
4-Chloro-3-methylphenol	30.0
2,4,6-Trichlorophenol	30.0
Acenaphthene	30.0
N-Nitrosodiphenylamine	30.0
Pentachlorophenol	30.0
Fluoranthene	30.0
Di-n-octyl phthalate	30.0
Benzo(a)pyrene	30.0

EPA = U.S. Environmental Protection Agency
 SPCC = System Performance Check Compounds
 RRF = Average Relative Response Factor
 CCC = Calibration Check Compounds
 RSD = Relative Standard Deviation

Table 8

SPIKING COMPOUNDS FOR ORGANIC ANALYSES

<u>EPA METHOD</u>	<u>SPIKING COMPOUNDS</u>
8010	1,1-Dichloroethylene Chlorobenzene Trichloroethylene
8240	1,1-Dichloroethylene Benzene Trichloroethylene Toluene Chlorobenzene
8080	Aroclor 1260 Aldrin p,p'-DDT Dieldrin Endrin Heptachlor BHC, gamma isomer (Lindane)
8270	Phenol 2-Chlorophenol 1,4-Dichlorobenzene N-Nitroso-di-n-propylamine 1,2,4-Trichlorobenzene 4-Chloro-3-methylphenol Acenaphthene 4-Nitrophenol 2,4-Dinitrotoluene Pentachlorophenol Pyrene

Table 9

**SURROGATE COMPOUNDS WITH
QUALITY CONTROL CRITERIA FOR ORGANIC ANALYSES**

EPA METHOD	SURROGATE COMPOUNDS	ACCURACY	
		Water (percent)	Soil (percent)
8010	Bromodichloromethane	69 - 140	42 - 196
8240	Bromofluorobenzene	83 - 115	55 - 125
	1,2-Dichloroethane	54 - 122	60 - 120
	Toluene-d8	86 - 113	70 - 120
8270	Nitrobenzene-d5	35 - 126	20 - 140
	2-Fluorobiphenyl	43 - 125	20 - 140
	Terphenyl-d14	33 - 151	20 - 140
	Phenol-d14	10 - 103	20 - 140
	2-Fluorophenol	21 - 118	20 - 140
	2,4,6-Tribromophenol	10 - 133	20 - 140
8080	Tetrachloro-meta-xylene	20 - 140	40 - 140
	Decachlorobiphenyl	20 - 147	50 - 164

Notes: The surrogate compounds listed for the above method are those specified by EPA SW-846 (EPA, 1992); one or more of these surrogate compounds may be used for sample analysis.

EPA = U.S. Environmental Protection Agency

Table 10

STATIC WATER LEVEL DATA SHEET

Month/Year: _____

Project Number: _____

[illegible]

CHAIN-OF-CUSTODY RECORD AND ANALYSIS REQUEST FORM

PINK: TASK MANAGER

GROUNDWATER SAMPLING INFORMATION
WELL ID: _____

DATE: _____
INITIALS: _____

[illegible]

Table 13

ELECTRICAL CONDUCTIVITY METER CALIBRATION FORM

Project Number: _____

Month/Year: _____

Page _____ of _____

[illegible]

pH METER CALIBRATION FORM

Page _____ of _____

[illegible]

SOIL GAS FIELD SAMPLING DATA

Page ____ of ____

DATE: _____

JOB NUMBER: _____

PERSONNEL: _____

WEATHER: _____

LOCATION: _____

CONTRACTOR PERSONNEL: _____

TYPE DRIVE HAMMER: _____

[illegible]

Table 16

**ENGLAND & ASSOCIATES
HARGIS + ASSOCIATES, INC.
DATA QUALIFIERS**

- S** Analytical result is satisfactory; no quality control problems were identified.
- E** The associated quantity is estimated because quality control criteria were not met for the following reasons:
- .. Project accuracy goals were not achieved.
 - .. Potential blank contamination.
 - .. Analytical holding times were exceeded.
 - .. Project precision goals were not achieved.
 - .. Data trending problems; no other quality control problem was identified.
- U** The associated quantity may be unusable according to the data quality objectives for the activity for one of the following reasons:
- .. Probable blank contamination.
 - .. Data trending problems; no other quality control problem was identified.



STATE OF CALIFORNIA
California Regional Water Quality Control Board
Los Angeles Region

REQUIREMENTS FOR ACTIVE SOIL GAS INVESTIGATION
Well Investigation Program
(March 1994)

Volatile organic compounds (VOCs) within the unsaturated zone partition into the adsorbed, dissolved, free liquid, and vapor phases. Measurement of VOCs through an active soil gas investigation allows: 1) evaluation of whether waste discharges of VOCs have occurred which may impact groundwater, 2) determination of spatial pattern and extent of vapor phase soil contamination, 3) establishment of vapor distribution for the design of soil vapor extraction system (SVE), and 4) determination of the efficiency of reduction in threat to groundwater from any cleanup action, including SVE. The work plan should include, but not be limited to, the following:

1.0 SURVEY DESIGN (LOCATION, NUMBER, DEPTH, DATA QUALITY OBJECTIVES)

1.1

Provide a scaled facility map depicting potential sources and proposed sampling points. Include locations and coordinates of identifiable geographic landmarks (e.g., street center-line, benchmark, street intersection, wells, north arrow, property line).

1.2

Locate initial sampling points in potential sources and areas with known soil contamination using an adjustable 10 to 20 foot grid pattern. Provide rationale for the number, location and depth of sampling points. Screen the remainder of the site with a 100-foot or less grid pattern.

1.3

Conduct a close interval (10 to 20 foot grid pattern) and multi-level sampling (5 to 10 feet vertically between points) in areas with known soil contamination and relatively high VOC concentrations.

1.4

Employ an on-site mobile laboratory with laboratory-grade certifiable instrumentation and procedures for real-time analysis of individual VOCs. Non-specific portable organic vapor analyzers and/or GC-based handheld detectors may not be used for analysis (during SVE they may be used for daily or weekly vapor monitoring).

1.5

Maintain flexibility in the sampling plan such that field modifications (grid pattern density, location and depth) can be made as real-time evaluation of analytical test results occurs. Include in the work plan decision-making criteria for these adjustments and explain decisions in the report. Field decisions shall be made in consultation with Regional Board staff.

1.6

Re-sample at any sampling point if anomalous data (i.e., 2 to 3 orders of magnitude difference from surrounding samples) are obtained. Additional points may be required to resolve the spatial distribution of the contaminants within the interval in question.

2.0 SAMPLE COLLECTION

2.1

Obtain samples at an adequate depth (nominally 5 feet) below ground surface (bgs) to minimize potential dilution by ambient air.

2.2

Conduct a site-specific purge volume versus contaminant concentration test at the start of the survey. Conduct this test based on soil type and where VOC levels are suspected to be highest. Adjust the purge rate and time to achieve the optimal purge volume. Discuss specific methods to determine optimal purge rates and volumes. In general, minimize purging to ensure that samples are representative of VOC concentrations at the probe tip. Note that the optimum purge volume may be compound specific. Therefore, it must be selected, in some cases, based on one target compound.

2.3

Explain expected zone of influence for sample points, taking into consideration soil types, land cover, drive point construction and sample purge rate/time/volume. The vertical zone of influence for purging and sampling must not intersect the ground surface.

2.4

Discuss soil gas sample collection, handling and testing procedures. Discuss procedures to prevent collection of samples under partial vacuum.

2.5

Discuss procedures to minimize equipment cross-contamination between sampling points.

2.6

Specify that the sampling equipment (e.g., gas tight syringe, sorbent trap) will not compromise the integrity of the samples. Tedlar bags may only be used for qualitative analysis.

2.7

Assure that the probe tip, probe and probe connectors have the same diameter to provide a good seal between the formation and the sampling assembly. If a space develops between the probe and the formation, as a result of probe advancement, seal (e.g., with bentonite) the area around the probe at the surface to minimize the potential for ambient air intrusion.

2.8

Some sampling systems utilize the probe as a conduit for Teflon tubing that connects to the probe tip. Assure that ambient air in the annular space between the probe and tubing is not in contact with the probe tip.

3.0 LABORATORY ANALYSIS OF SOIL GAS SAMPLES

3.1 TARGET COMPOUNDS

- | | |
|---|---|
| 1. Carbon tetrachloride | 13. 1,1,1-Trichloroethane |
| 2. Chloroethane | 14. 1,1,2-Trichloroethane |
| 3. Chloroform | 15. Trichloroethene |
| 4. 1,1-Dichloroethane | 16. Vinyl chloride |
| 5. 1,2-Dichloroethane | 17. Benzene |
| 6. 1,1-Dichloroethene | 18. Toluene |
| 7. cis-1,2-Dichloroethene | 19. Ethylbenzene |
| 8. trans-1,2-Dichloroethene | 20. Xylenes |
| 9. Dichloromethane (methylene chloride) | 21. Trichlorofluoromethane (Freon 11) |
| 10. Tetrachloroethene | 22. Dichlorodifluoromethane (Freon 12) |
| 11. 1,1,1,2-Tetrachloroethane | 23. 1,1,2-Trichloro-trifluoroethane (Freon 113) |
| 12. 1,1,2,2-Tetrachloroethane | |

3.2 OTHER TARGET COMPOUNDS

Analysis of other VOCs (e.g., methyl ethyl ketone, methyl isobutyl ketone, ethylene dibromide, petroleum hydrocarbons, etc.) may be required based upon site history and conditions.

3.3 DETECTION LIMIT (DL)

Attain DL of not more than 1 $\mu\text{g/L}$ for all target compounds. Higher DL is acceptable only for the compound(s) whose concentration exceeds the initial calibration range.

3.4 DETECTORS

The following detectors may be used in appropriate combinations:

- Electrolytic conductivity detector (ELCD) (e.g., Hall)
- Photoionization detector (PID)
- Flame ionization detector (FID)
- Mass spectrometer (MS)
- Electron capture detector (ECD)

3.5.0 IDENTIFICATION OF CALIBRATION STANDARDS & LABORATORY CONTROL SAMPLE (LCS)

3.5.1

All calibration standards and LCS must be properly and clearly identified. The identification must agree with the data on record for the standards & LCS.

3.5.2

Prepare LCS from a second source standard that is totally independent from calibration standards used for the initial calibration. Second source means a different supplier (whenever possible) or a different lot from the same supplier.

3.6.0 GC CONDITIONS

3.6.1

Use a type of column that can separate all the target compounds. No coelution of the target compounds is acceptable unless the compounds can be distinguished and quantified by two different types of detectors in use at that time.

3.6.2

Analyze the initial calibration and daily mid-point calibration check standards, LCS, blank, and samples using the same GC conditions (i.e., detector, temperature program, etc.).

3.6.3

The GC run time must be long enough to identify and quantify all the target compounds.

3.7.0 INITIAL CALIBRATION

3.7.1

Perform an initial calibration:

1. for all 23 compounds listed in Section 3.1;
2. when the GC column type is changed;
3. when the GC operating conditions have changed;
4. when the daily mid-point calibration check cannot meet the requirement in Section 3.8.3; and
5. when specified by Regional Board staff based on the scope and nature of the investigation.

3.7.2

The initial calibration must consist of at least three different concentrations of the standard, with the lowest one not exceeding 5 times the DL for each compound.

3.7.3

Calculate the response factor (RF) for each compound and calibration concentration prior to analyzing any site samples. Calculate the average RF for each compound. The percent relative standard deviation (%RSD) for each target compound must not exceed 20% except for the following compounds which must not exceed 30%:

Trichlorofluoromethane (Freon 11)
Dichlorodifluoromethane (Freon 12)
Trichlorotrifluoromethane (Freon 113)

Chloroethane
Vinyl chloride

3.7.4

Verify the true concentration of the standard solutions used with the LCS after each initial calibration. Conduct the verification using a LCS with a mid-point concentration within the initial calibration range. The LCS must include all the target compounds and the RF must be within $\pm 15\%$ difference from the initial calibration.

3.8.0 DAILY MID-POINT CALIBRATION CHECK

3.8.1

Check the calibration using the calibration standard solution with a mid-point concentration within the linear range of the initial calibration before any sample is analyzed.

3.8.2

The daily mid-point check must include the following compounds and every compound expected or detected at the site:

- | | | |
|---------------------------|-----------------------------|--------------------|
| 1. 1-Dichloroethane | 5. trans-1,2-Dichloroethene | 9. Trichloroethene |
| 2. 1,2-Dichloroethane | 6. Tetrachloroethene | 10. Benzene |
| 3. 1,1-Dichloroethene | 7. 1,1,1-Trichloroethane | 11. Toluene |
| 4. cis-1,2-Dichloroethene | 8. 1,1,2-Trichloroethane | 12. Xylenes |

3.8.3

The RF of each compound (except for freons 11, 12 and 113, chloroethane, and vinyl chloride) must be within 85% to 115% of the average RF from the initial calibration. The RF for freons 11, 12 and 113, chloroethane, and vinyl chloride must be within 75% to 125%.

3.9.0 BLANK

3.9.1

Analyze field blank(s) to detect any possible interference from ambient air.

3.9.2

Investigate and determine the source(s) and resolve any laboratory contamination problem prior to analyzing any samples if the blank shows a measurable amount ($\geq 1 \mu\text{g/L}$) of the target compound(s).

3.10.0 SAMPLE ANALYSIS

3.10.1

The requirements for initial calibration, daily mid-point check, blank, and LCS must be met before any site samples are analyzed.

3.10.2

Analyze samples within 30 minutes after they are collected to minimize VOC loss. Longer holding time may be allowed if the laboratory uses a special sampling equipment (e.g., sorbent trap, glass bulb) and demonstrates that the holding time can exceed 30 minutes with no decrease in results.

3.10.3

The concentrations of constituent(s) in a sample must not exceed 50% above the highest concentration in the calibration range. Reanalyze the sample using a smaller volume or dilution if 50% above the highest concentration in the calibration range is exceeded.

3.10.4

Attain DL of not more than 1 $\mu\text{g/L}$ for all target compounds. If lesser sample volumes or dilutions are used to off-set possible high concentration of constituents in the initial run, the initial run must be used to calculate the results for constituents that are not affected by the high concentration so that DL of 1 $\mu\text{g/L}$ for these compounds can be achieved.

3.10.5

Quantify sample results using the average RF from the most recent initial calibration.

3.10.6

Add surrogate compounds to all samples if GC/MS is not used for analysis or compound confirmation.

3.11.0 COMPOUND CONFIRMATION

3.11.1

Conduct compound confirmation by GC/MS or surrogate compounds and second column.

3.11.2

If MS is used for analysis, identification must be done through mass spectrum and retention time comparison. Surrogate analysis and second column confirmation are not mandatory.

3.11.3

If surrogate compounds are used, they must be added to all calibration and daily mid-point check standards, blanks, site samples, and samples for second column confirmation to calculate the relative retention time (RRT) for monitoring the retention time shift between GC runs. This is recommended for better compound identification when ELCD, PID, ECD, and FID are used for analysis. Two to three different surrogate compounds should be used to cover the different temperature programming range for each GC run.

3.11.4

Surrogate compound concentration must be within the initial calibration range.

3.11.5

Use a surrogate in second column confirmation. Usually one sample is adequate and quantitation is not required. Second column confirmation can be done with a different GC. The representative sample can be collected in Tedlar bag and confirmation can be done off site.

3.11.6

Second column confirmation is not necessary if the compounds present have been identified from confirmed from previous soil gas investigations.

3.12.0 SAMPLES WITH HIGH CONCENTRATION

3.12.1

DL may be raised above 1 $\mu\text{g/L}$ for compounds with high results (i.e., the limit as specified in Section 3.10.3) and those closely eluting compounds for which quantitation may be interfered by the high concentrations.

3.12.2

Quantify sample results according to Section 3.10.4 for analytes which are not affected by the high concentration compounds.

3.12.3

If high concentration in an area is known from previous soil gas analysis, Sections 3.12.1 and 3.12.2 are not necessary when analyzing samples from the area in question.

3.12.4

When dilution with ambient air is used for samples with high results, at least one sample must be diluted and analyzed in duplicate each day to verify the dilution procedure. Ambient air should be checked periodically during each day of analysis.

3.13.0 SHORTENED ANALYSIS TIME

3.13.1

Shorten the GC run time under the following conditions only:

1. The exact number and identification of compounds are known from previous soil and soil gas investigations; and
2. The consultant has been given permission by Regional Board staff to analyze only for specific compounds.

3.13.2

Meet the following requirements when shortening GC run-time:

1. The shortened run time must be approved by Regional Board staff;
2. The compounds must not coelute;
3. Initial calibration, daily mid-point calibration check, LCS, and samples must be analyzed under the same conditions as the shorter GC run-time;
4. Quantitations must be done using the average RF from the initial calibration utilizing the shorter run-time; and
5. A normal run-time must be performed whenever peaks are detected within retention time windows where coelution, as indicated by the calibration chromatograms, is likely.

3.14.0 LAST GC TEST RUN PER DAY OF ANALYSIS

3.14.1

Analyze a LCS as the last GC run of the day. Include the same compounds used in the daily mid-point calibration check analysis, as listed in Section 3.8.2. The RF for each compound must be within 80% to 120% of the average RF from the initial calibration. If the RF is not within these limits, all test results generated from the same day will be considered questionable and may be rejected by this Regional Board.

3.14.2

Analyze a LCS at the detection limit concentration instead of the mid-point concentration if all samples from same day of analysis show non-detect (ND) results. The recovery for each compound must be at least 50%. If it is less than 50%, all the ND results of the samples become questionable.

3.15.0 ON-SITE EVALUATION CHECK SAMPLE

3.15.1

Analyze on-site the evaluation check sample as part of the QA/QC procedures when presented with such a check sample by Regional Board staff. Provide preliminary results on-site.

3.15.2

If the results show that the soil gas consultant has problems with the analysis, all the results generated during the same day may be rejected. Correct all problems before any more samples are analyzed.

3.16.0 SITE INSPECTION

3.16.1

Unannounced, on-site inspection by Regional Board staff is routine. During the inspection, hard copies of the complete laboratory data, including raw data for initial calibration, daily mid-point check, LCS and blank results must be provided upon request. Failure to allow such inspection or to present these records or field data may result in rejection of all sample results.

3.16.2

The soil gas consultant must understand the instruments, analytical and QA/QC procedures and must be capable of responding to reasonable inquiries.

3.17.0 RECORDKEEPING IN THE MOBILE LABORATORY

Maintain the following records in the mobile laboratory:

1.. A hard copy record of calibration standards and LCS with the following information:

- | | | | |
|----|---|----|--|
| a) | Date of receipt | f) | Name of person who performed the dilution |
| b) | Name of supplier | g) | Volume of concentrated solution taken for dilution |
| c) | Lot number | | |
| d) | Date of preparation for intermediate standards (dilution from the stock or concentrated solution from supplier) | h) | Final volume after dilution |
| | | i) | Calculated concentration after dilution |
| e) | ID number or other identification data | | |

2. A hard copy of each initial calibration for each instrument used for the past few months.

3. The laboratory standard operating procedures.

4.0 REPORTING OF SOIL GAS SAMPLE RESULTS AND QA/QC DATA

4.1

Report all sample test results and QA/QC data. Include in the table of sample results all compounds on the analyte list. Report unidentified or tentatively identified peaks. All raw data including the chromatograms must be submitted upon request.

4.2

Report the following for all calibration standards, LCS and environmental samples:

- | | |
|---------------------|---|
| 1. Site name | 5. Instrument identification |
| 2. Laboratory name | 6. Normal injection volume |
| 3. Date of analysis | 7. Injection time |
| 4. Name of analyst | 8. Any special analytical conditions/remark |

4.3

Provide additional information, as specified, for different types of analyses. Tabulate and present in a clear legible format all information according to the following grouping:

1. Initial calibration

- a) Source of standard (STD LOT ID NO.)
- b) Detector for quantitation (DETECTOR)
- c) Retention time (RT)
- d) Standard mass or concentration (MASS/CONC)
- e) Peak area (AREA)
- f) Response factor (RF)
- g) Average response factor (RF_{ave})
- h) Standard deviation (SD_{n-1}) of RF, i.e.,
$$\left[\sum_{i=1}^n (RF_{ave} - RF_i)^2 / (n - 1) \right]^{1/2}$$

n = number of points in initial calibration
- i) Percent relative standard deviation (%RSD), i.e., $(SD_{n-1} / RF_{ave}) \cdot 100$ (%)
- j) Acceptable range of %RSD (ACC RGE)

2. Daily calibration check sample

- | | |
|-----------------------------------|--|
| a) Source of standard | f) Response factor (RF) |
| b) Detector | g) Percent difference between RF and RF_{ave} from initial calibration (%DIFF) |
| c) Retention time (RT) | h) Acceptable range of %DIFF (ACC RGE) |
| d) Standard mass or concentration | |
| e) Peak area | |

3. LCS. Same format as daily calibration

4. Environmental sample

- | | |
|--|---|
| a) Sample identification | i) Detector for quantitation |
| b) Sampling depth | j) Retention time (RT) |
| c) Purge volume | k) Peak area |
| d) Vacuum pressure | l) Concentration in $\mu\text{g/L}$ (CONC) |
| e) Sampling time | m) Total number of peaks found by each detector |
| f) Injection time | n) Unidentified peaks and/or other analytical remarks |
| g) Injection volume | |
| h) Dilution factor (or concentration factor if trap is used) | |

5. Surrogate and second column confirmation

Mark RT and compound name on: a) second column chromatogram of standard and b) second column chromatogram of confirmation sample.

4.4

Use the QA/QC and results reporting formats in Appendix A. Compounds may be listed by retention time or in alphabetical order.

4.5

Discuss the method(s) to be used for data interpolation (contouring). Isoconcentration maps for each VOC detected, total chlorinated volatile organics, total aromatic hydrocarbons, and petroleum-based hydrocarbons must be provided for each sampling depth, as appropriate, and included in the final report. Provide cross-section(s) depicting the geology and changes in contaminant concentration with depth, as justified by the data.

5.0 COMPANION SOIL SAMPLING

5.1

Discuss soil boring locations with Regional Board staff.

5.2

Boring locations and sampling depths will be based upon all available information including soil gas survey test results.

5.3

Conduct the soil sampling and analysis per this Regional Board's **Well Investigation Program General Requirements for Subsurface Investigations, Requirements for Subsurface Soil Investigation and Laboratory Requirements for Soil and Water Sample Analyses.**

6.0 VERTICAL PROFILING/NESTED VAPOR PROBES

Install nested vapor probes for vertical profiling in areas where significant VOCs were identified during the initial investigation. The objectives of vertical profiling are to: 1) assess the vertical distribution of VOCs in the vapor phase within the unsaturated zone, 2) determine the spatial pattern of vapor phase soil contamination at different depths within the unsaturated zone, 3) identify migration pathways at depths along which VOCs may have migrated from sources, and 4) serve as discrete monitoring points to evaluate the efficiency of a cleanup action.

Address appropriate items in the following sections when vertical profiling is conducted.

6.1

Collect undisturbed soil samples if fine-grained soils are encountered during drilling of the boring for the probes. Due to air-stripping effect, VOC analysis of soil samples is not required if air drilling method is used. Refer to Section 5.3 for sampling and testing requirements.

6.2

Use all available information (e.g., geologic log) to select appropriate depths for vapor monitoring. Probes should be installed slightly above fine-grained soils which can retard the migration of VOCs. The deepest probe should be installed above the capillary fringe.

6.3

Consider installing nested probes in the annular space of groundwater monitoring wells, especially in areas with coarse-grained soils where collection of soil samples is difficult and sites where VOC remediation may be required.

6.4

Use small-diameter (e.g., $\leq 1/4$ inch) continuous tubing attached from the probe to the ground surface to minimize purge volume. If a plastic/flexible tubing is used, consider attaching a weight at the probe tip to ensure that the tip remains in-place during installation.

6.5

Extend the sand pack around the vapor probe a sufficient distance above the probe to allow for settling of back-fill materials. Place bentonite seals between the sand packs to isolate the sampling zones. In general, the sand pack should not exceed 2 feet in thickness. In deep borings, the sand pack should extend about four feet above the probe to allow for settling of back-fill materials and to reduce the potential for the bentonite seal settling around the probe.

6.6

Provide a schematic diagram of the nested probe design and a cross-section of the site showing the major lithologic units and zones for vapor monitoring.

6.7

Specify the schedule for sampling each probe. In general, soil gas monitoring is required one month and two months after installation. Regional Board staff may require a different sampling schedule and additional sampling based upon site conditions and test results.

7.0 PARTIAL LIST OF SOIL GAS CONSULTANTS

A partial list of soil gas consultants is available for the convenience of the public who require assistance to select soil gas consultants for conducting soil gas investigations.

Regional Board staff requested soil gas consultants to submit a laboratory data package demonstrating their analytical capabilities. We have found the analytical testing methods of the soil gas consultants on the list to be acceptable. Although other soil gas consultants not on the list may be used, mobile laboratory capabilities must be demonstrated prior to performing any work. Sample collection and handling procedures employed must not compromise the integrity of the samples.

Retaining a soil gas consultant from the list does not assure acceptance of that consultant's work. This Regional Board reserves the authority to review any soil gas consultant's work to assure compliance with all applicable statutes, regulations, orders, and guidelines. It is your responsibility to ascertain that the individual directing the field investigation is professionally qualified and conducts the field work in an acceptable manner.

ACKNOWLEDGEMENTS

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APPENDIX A

SOIL GAS INITIAL CALIBRATION

SITE NAME: _____ LAB NAME: _____ DATE: _____

ANALYST: _____ STD LOT ID NO.: _____ INSTRUMENT ID: _____

NORMAL INJECTION VOLUME: _____ INJECTION TIME: _____

COMPOUND	DETECTOR	1st CONC			2nd CONC			3rd CONC			RF _{ave}	SD _{n-1}	%RSD	ACC RGE
		RT/RRT	MASS/CONC	AREA	RF	RT/RRT	MASS/CONC	AREA	RF	RT/RRT				

----- OR -----

COMPOUND	DETECTOR	RT/RRT	MASS/CONC	AREA	RF	RF _{ave}	SD _{n-1}	%RSD	ACC RGE
----------	----------	--------	-----------	------	----	-------------------	-------------------	------	---------

Compound 1

_____	<u>1st conc</u>	_____	_____
_____	<u>2nd conc</u>	_____	_____
_____	<u>3rd conc</u>	_____	_____

Compound 2
(Surrogate)

SOIL GAS DAILY MID-POINT CALIBRATION STANDARD

AND

SOIL GAS LABORATORY CONTROL SAMPLES (LCS)

SITE NAME: _____ LAB NAME: _____ DATE: _____

ANALYST: _____ STD LOT ID NO.: _____ INSTRUMENT ID: _____

NORMAL INJECTION VOLUME: _____ INJECTION TIME: _____

COMPOUND (SURROGATE)	DETECTOR	RT/RRT	MASS/CONC	AREA	RF	%DIFF	ACC RGE
-------------------------	----------	--------	-----------	------	----	-------	---------

SOIL GAS SAMPLE RESULTS

SITE NAME: _____ LAB NAME: _____ DATE: _____

ANALYST: _____ COLLECTOR: _____ INSTRUMENT ID: _____

NORMAL INJECTION VOLUME: _____

Sample ID	Sample 1	Sample 2	Sample 3
Sampling Depth			
Purge Volume			
Vacuum			
Sampling Time			
Injection Time			
Injection Volume			
Dilution Factor			

COMPOUND	DETECTOR	RT	AREA	CONC	RT	AREA	CONC	RT	AREA	CONC
----------	----------	----	------	------	----	------	------	----	------	------

Compound 1
Compound 2
Compound 3
.
.
.
.
.

Surrogate 1
Surrogate 2

Total Number of Peaks
by Detector 1 (specify)
by Detector 2 (specify)

Unidentified peaks and/or other analytical remarks

ALTERNATIVE FORMAT FOR REPORTING SOIL GAS SAMPLE RESULTS

SITE NAME: _____ LAB NAME: _____ DATE: _____

SITE NAME: _____ LAB NAME: _____ DATE: _____

ANALYST: _____ COLLECTOR: _____ INSTRUMENT ID: _____

NORMAL INJECTION VOLUME: _____

Sample ID	Sample 1	Sample 2	Sample 3 ...
Sampling Depth			

COMPOUND	CONC	CONC	CONC
----------	------	------	------

Compound 1
Compound 2
Compound 3

Sample ID	Sample 1	Sample 2	Sample 3 ...
-----------	----------	----------	--------------

Sampling Depth
 Purge Volume
 Vacuum
 Sampling Time
 Injection Time
 Injection Volume
 Dilution Factor

COMPOUND	DETECTOR	RT	AREA	RT	AREA	RT	AREA
----------	----------	----	------	----	------	----	------

Compound 1
Compound 2
Compound 3

Surrogate 1
Surrogate 2

Total Number of Peaks
by Detector 1 (specify)
by Detector 2 (specify)

Unidentified peaks and/or other analytical remarks

Appendix F



**HYDRO GEO CHEM'S SOIL GAS PROCEDURES:
FIELD SAMPLING, MOBILE-LABORATORY ANALYSIS
AND QUALITY ASSURANCE/ QUALITY CONTROL**

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Note: Because some of the information in this document is proprietary to Hydro Geo Chem, it may only be utilized to review the accompanying proposal and may not be disseminated.

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**Hydro Geo Chem's Soil Gas Procedures:
Field Sampling, Mobile-Laboratory Analysis
and Quality Assurance/ Quality Control**

SUMMARY OF METHOD

This document describes the methods that Hydro Geo Chem provides for sampling and analysis of volatile organic compounds (VOCs) in soil gas. The methods have been designed to maximize accuracy and minimize contamination. The methods meet or exceed Level III QA/QC requirements.

1. SAMPLING

1.1 Scope and Application

This section covers the materials, equipment and procedures that are utilized by Hydro Geo Chem, Inc. for collecting soil gas samples in the field.

1.2 Sampling Equipment

1.2.1 Sampling Probes and Drive Point Rigs

Sampling probes consist of 5-foot sections of nickel plated, flush-threaded, 1 $\frac{3}{8}$ " hardened EW drill rod tipped by a high carbon point connected to a stainless steel adaptor. The drive point rig, the most powerful in the industry, is a 1.5 ton Ford 450 truck equipped with a boom-mounted 250 or 350 ft-lb hydraulic jack hammer. The probe is pushed and/or hammered into the formation until it reaches a target depth. Probes are recovered using a pulling dog and the hydraulic lift in the boom or, when driven deeply into a tight formation, by employing the heavy-duty hydraulic lift/stabilizers attached to the back of the truck.

In limited-access areas, the use of a drive point rig may not be possible. Probe driving in these cases can be accomplished by using either a hand held driver or an air compressor, air line, and pneumatic post hole driver. The probes are recovered by using a mechanical probe jack.

1.2.2 Soil Gas Sampling Apparatus

Gas samples are collected from the stainless steel adaptor mounted on the distal (deep) end of the sampling train. A stainless steel Dart® sampler is connected to 1/4-inch clean, virgin polyethylene tubing, lowered down the center of the drive probe string, and mated to the stainless steel adaptor. The top of the polyethylene tubing is then connected to a Swagelok stainless steel "T" fitting equipped with a septum for syringe

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sampling. The third port of the "T" fitting is connected via 1/4 inch virgin polyethylene tubing to a vacuum pump. The pumping system employed will be a portable vacuum tank equipped with a vacuum gage that is calibrated in both pressure and volume.

1.2.3 Sampling Devices

Soil gas samples are collected in 10 mL, gas-tight, all glass and Teflon syringes equipped with a built-in on-off valve (Dynatech A-2).

1.3 Sample Collection

1.3.1 Pre-Sample Purge

The probe is purged before collecting a soil gas sample to ensure that a representative sample is collected. The purging pump (vacuum tank) is connected to the evacuation port of the "T" fitting, and the specified volume of gas is withdrawn. Total purge volume is three times the sum of the volume of the tubing, void volume of the point, and volume of the hole resulting from probe pull-back, a total, typically, of 600 mL of gas. After purging, the valve to the vacuum tank is shut, and the vacuum gage is monitored until the line returns to atmospheric pressure.

1.3.2 Soil Gas Sampling

A syringe is inserted into the septum port of the sampling "T" after allowing the system to return to atmospheric pressure. A 10 mL aliquot of soil vapor is withdrawn from the probe. Duplicate samples are collected at all locations.

1.4 Decontamination of Equipment

Sampling equipment is decontaminated by methods consistent with the equipment's use. Drive rod and drive points are steam cleaned using Liquinox non-phosphate detergent, steam cleaned again with potable water, drained hot, and allowed to dry. Small stainless-steel parts including adaptors, DART® samplers, and sampling "Tees" are cleaned by washing with Alconox, then distilled water, and baking in a convection oven for at least 20 minutes at 120 °C. Syringes are cleaned by washing with Alconox and water and drying at 50 °C in a forced UHP nitrogen stream in an HGC-designed syringe cleaner. Methanol or hexane rinses that can carry contamination, contribute to hydrocarbon background, and potentially trap VOCs are not employed.

Separate storage areas are provided for used and cleaned equipment. The rod and points are stored in clean storage areas on the drive point rigs. Care is taken with the rods and points to eliminate both soil-surface and cross-hole contamination. Vinyl or latex surgical gloves are worn during handling and assembly of the sampling apparatus. No equipment is used or reused without being decontaminated.

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2. ANALYSIS

Summary of Analytical Method

For each soil gas sample injection, Hydro Geo Chem performs two simultaneous analyses by splitting the injection to two columns and two sets of detectors. Confirmatory gas chromatographic analysis is thus provided for every sample. The first analysis is best described by the EPA Method 8021 (or the older Method 8010/8020), an analysis for volatile chlorinated hydrocarbons and aromatic species. The method employs a DB 624 megabore capillary that leads to a Hall and PID detector combination. Table 1 lists the compounds that can be analyzed using the EPA 8021 protocol. A compound subset of Table 1 is commonly selected as more suitable for soil-gas investigations. For example, the analyte list presented in Table 2 is required for active soil gas investigations by the State of California Water Quality Control Board, Los Angeles Region (CRWQCB). In addition to the analyses of each compound, the cumulative area for the Hall detector chromatogram provides a measure of the total concentration of chlorinated hydrocarbons.

The second analysis performed for each soil gas sample employs a DB-1 megabore capillary chromatographic column that leads to a flame ionization detector (FID). The method is best described as a modified EPA Method 8015. The EPA 8015 protocol is suitable for the analysis of volatile hydrocarbons, including methane; common solvents such as ketones and alcohols, and substances such as gasoline, diesel, and JP fuels. In addition, the total peak area provides a measure of total FID volatiles.

To provide better precision and accuracy, allow greater throughput, and to minimize the potential for laboratory contamination, we have modified the above VOC analysis methods as follows:

1. Gas standards are employed rather than gas-diluted water-solution standards. The gas standards are contained in stainless steel Summa canisters. The advantages of gas standards are (1) These standards hold their concentrations indefinitely. Their use prevents errors common to daily standard preparation. (2) Using gas, rather than liquid, standards, avoids the matrix effects associated with liquid standard solutions. The water or methanol commonly used to carry liquid standards interfere with analysis of early-eluting peaks, contribute a large solvent peak, and attack and gradually destroy the reaction tube in a Hall detector. (3) Contamination of the analytical or sampling apparatus, which can occur when liquid standards are handled, is essentially eliminated by using the gas canisters.

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TABLE 1. LIST OF COMPOUNDS SPECIFIED IN USEPA METHOD 8021 PROTOCOL

benzene	2-chlorotoluene	cis-1,2-dichloroethene
bromobenzene	4-chlorotoluene	trans-1,2-dichloroethene
bromochloromethane	dibromochloromethane	1,2-dichloropropane
bromodichloromethane	1,2-dibromo-3-chloropropane	1,3-dichloropropane
bromoform	1,2-dibromoethane	2,2-dichloropropane
bromomethane	dibromomethane	1,1-dichloropropane
n-butylbenzene	1,2-dichlorobenzene	ethyl benzene
sec-butylbenzene	1,3-dichlorobenzene	hexachlorobutadiene
tert-butylbenzene	1,4-dichlorobenzene	isopropylbenzene
carbon tetrachloride	dichlorodifluoromethane	p-isopropyltoluene
chlorobenzene	1,1-dichloroethane	methylene chloride
chloroethane	1,2-dichloroethane	naphthalene
chloroform	1,1-dichloroethene	n-propylbenzene
chloromethane		

Table 2. Subset of Table 1 Analytes Commonly Required for Soil Gas Investigations

carbon tetrachloride	1,1,1-trichloroethane (1,1,1-TCA)
chloroethane	1,1,2- trichloroethane
chloroform	trichloroethene (TCE)
1,1-dichloroethane	vinyl chloride
1,2-dichloroethane	benzene
1,1-dichloroethene	toluene
cis-1,2-dichloroethene	ethylbenzene
trans-1,2-dichloroethene	o-xylene
dichloromethane (methylene chloride)	m-, p-xylenes
tetrachloroethene (PCE)	trichlorofluoromethane (Freon 11)
1,1,1,2- tetrachloroethane	dichlorodifluoromethane (Freon 12)
1,1,2,2-tetrachloroethane	1,1,2-trichloro-trifluoroethane (Freon 113)

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2. Samples are injected into loops that are connected to switching valves in such a way that sample injection completely fills the loop at atmospheric pressure (there is no back pressure to compromise the accuracy of the syringe injection). Computerized switching of the valve introduces the contents of the loop into the column. This procedure substantially improves precision and accuracy of the analysis. The sample volume is more accurate because losses do not occur during injection, and the timing of the injection process is identical for every sample, improving reproducibility. An second advantage is the ability to hold the sample in the loop without the possibility of leakage or adsorptive loss. Analytical throughput is increased by programming the computer to maintain a maximum sample analysis rate over a longer time period than practicable with manual injection. Loop injection also provides the opportunity to inject precise smaller volumes, necessary when high concentrations in the field exceed the linear range of the analytical instrument.

3. Surrogates are added to each sample injection. The surrogate compounds have been carefully selected for detectability by each of the three detectors employed. These surrogates are automatically injected via a precision-volume loop in series and provide a quantitative measure of the performance of the instrument both in retention time and in instrument sensitivity. Thus for each analysis a judgement can be made as to whether the instrument is operating normally and, if not, whether the flow, temperature programming, or detector sensitivity have changed.

These methods offer a detection limit of at least 1.0 µg/l (soil gas), approximately 0.25 ppmv, and a linear range of 1-50,000 µg/l for each of the compounds listed in Tables 1 or 2.

The following sections document the materials, apparatus, and procedures used.

2.1 Scope

This section covers the equipment, materials, and procedures used to determine the concentrations of various volatile organic compounds in the soil gas samples.

2.2 Detection Limits

The method detection limit (MDL) is less than 1.0 µg/L for each VOC soil gas analyte.

2.3 Apparatus and Equipment

2.3.1 Gas Chromatographs

Hydro Geo Chem's mobile laboratories, used to provide on-site analyses, are housed in 14 to 18 foot custom built non-motorized trailers. The mobile laboratories are stand-alone vehicles that operate separately from the drive point rig, thereby allowing efficient operation of both. Each mobile lab is equipped with a Varian 3400, temperature programmable gas chromatograph (GC). Cryogenic cooling of the column is provided to below 0 °C.

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The GC is equipped with multi-port valves (Valco) in series, with fixed-volume loops installed. Soil gas samples or calibration standards are transferred from the syringe used for collection to the appropriately sized sample loop prior to analysis. Another loop is loaded with a surrogate mixture. The valves are equipped with air actuators providing simultaneous injection of both the surrogate(s) and sample (or standard). The compounds are held in the cooled columns (cryofocused) at the start of the chromatographic run. The time of sample injection is controlled by the computerized Labquest® integration system.

The carrier gas is ultra high purity helium at approximately 11 mL/minute. The carrier gas flow is augmented with a 25 mL/minute helium before entering the photoionization detector (PID) and an additional 40 mL/min ultra high purity hydrogen to optimize response of both PID and Hall electrolytic conductivity (Hall) detectors. The carrier gas is also augmented with hydrogen when it is routed to the flame ionization detector (FID).

2.3.2 GC Columns

For VOC analyses, Hydro Geo Chem's mobile laboratories employ 30 m x 0.53 mm DB 624 Megabore and DB 1 Megabore columns (both columns supplied by J&W Scientific). The helium flow rate is adjusted to approximately 5.5 mL/minute. The temperature program is as follows: initial column temperature at 2 °C, no hold, programmed to 35 °C at 15 degrees/minute, no hold, programmed to 125 °C at 8 degrees/minute, no hold, programmed to 200 °C at 15 degrees/minute, no hold.

2.3.3 Detectors

The PID is a Tracor Model 703 equipped with a 10.2 ev lamp.

The Hall electrolytic conductivity detector (ELCD) is a Tracor Model 1000 or 700A. Operating conditions are as follows:

Reaction tube:	Nickel 1/16" OD
Reactor temperature:	800 °C
Reactor base temperature:	200 °C
Electrolyte:	n-propyl alcohol
Electrolyte flow rate:	0.5 mL/min
Reaction gas:	hydrogen at 30 mL/min
Carrier gas plus make up:	helium at 30 mL/min

A Varian flame ionization detector, (FID), is also provided for analysis of total volatile hydrocarbons, volatiles not detected by the Hall-PID, and confirmation of detected compounds.

A Varian electron capture detector, (ECD) is used for sensitive analysis of multi-chlorinated compounds and selected soil-gas and groundwater tracers and

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A Varian thermal conductivity detector (TCD) is used for the analysis of the permanent gases.

2.3.4 Integrators.

Each mobile laboratory is equipped with a Tremetrics Labquest® computer integrating system. The data collected by the integrating systems are stored in a PARADOX® Data Base Management system that provides sample and QA/QC data and tabulates the soil gas data in a form suitable for contouring by SURFER®, a commercially available contouring system. Each computer also is equipped with CAD software for preparing, displaying, and laser printer plotting, and with WordPerfect for Windows 6.1 for preparing reports.

2.3.5 Standards and Reagents.

Standards are obtained as pure gases, as certified gas mixtures, or as neat reagent grade compounds. Standards are prepared by weight (weights traceable to NIST standards) and/or by volume from pure gases or certified gas mixtures of pure gases by precision volume syringes. The manufacturer, lot number, date and initial of the person receiving the compound or standard, expiration date of the compound or standard, and unique lab identifier for the compound or standard are kept in a logbook that documents all aspects of standard preparation. Soil gas calibration standards are made up by injecting known volumes of each compound or compound mixture into pressurized 6-liter Summa canisters and bringing the canister to pressure (monitored by a precision gauge) using UHP nitrogen or helium. The Summa canister, constructed from passivated stainless steel, is equipped with a bellows valve, pressure gauge, and septum-seal sample withdrawal port. The lot number, date and initial of the person receiving the Summa-canister standard, the expiration date of the Summa-canister standard, and unique lab identifier for the Summa-canister standard are kept in the logbook that documents all aspects of standard preparation and are attached to the Summa-canister for identification.

A spiking solution containing at least two compounds to be used as surrogates is similarly prepared and documented. The surrogates are selected so that they do not interfere with the compounds of interest. Typical compounds used as surrogates are fluorobenzene, 2-bromo-1-chloropropane, bromochloromethane, 1-chloro-2-bromobutane, 4-bromo-fluorobenzene, and 1,3 -trans- or cis-dichloropropene. The amount of surrogate selected is 3 to 5 times greater than the expected mid-range of concentrations found in the actual samples.

2.4 Calibration

2.4.1 Multipoint Calibration

A multipoint calibration curve is generated at the initiation of a project. The linearity of the calibration will be evaluated by performing a linear least-squares analysis and

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generating a correlation coefficient. The calibration will not be considered acceptable if the correlation coefficient is less than 0.995 or if the percent relative standard deviation (%RSD) exceeds 20%.

The multipoint calibration covers a range of concentrations, typically from three times the detection limit of 1 µg/L to 500 µg/L. Samples exceeding this range are injected via smaller precision-volume loops to extend the upper range by a factor of 100.

2.4.2 Daily Mid-range calibration

A mid-range standard calibration is performed at the beginning of the day to verify the instrument response. The standard is injected into the mid-range loop and analyzed. If the response varies from the previous response by greater than ±15%, appropriate measures are taken to correct the circumstances causing the variability or the system is recalibrated.

2.4.3 Response Factors

When the external standard method is used, Labquest®, the computer-integration system, calculates response factors as follows:

$$RF = A/C$$

where A = area of analyte to be measured
 C = concentration of analyte, µg/l

2.4.4 Retention Times

An acceptable retention time window is ±0.10 minutes from the average retention time derived from the daily calibration analyses.

2.5 Surrogates

The surrogate (or surrogates) are injected into precision volume loops connected in series with the sampling loops. For each sample analysis the accompanying analysis of the surrogate provides an independent check on the instrument response (all three detectors) and retention times (each column). If the surrogate response varies from the daily or continuing calibration surrogate response by greater than ±20%, appropriate measures are taken to correct the circumstances causing the variability or the system is recalibrated.

2.6 Quality Control

2.6.1 Field Blanks

Prior to each day's soil gas sampling, a field blank of the entire sampling apparatus that contacts soil gas, i.e., the stainless steel point holder, the DART® stainless steel sampler, a length of polyethylene tubing, and the septum-equipped stainless steel "Tee" sampling port. The field blank also serves as a method blank (see 2.6.2). The sampling apparatus is purged by injecting three apparatus volumes of UHP nitrogen into the point holder. A syringe sample is then taken at the sampling "Tee" and analyzed to check background contamination in the sampling system. Additional field blanks are collected after sampling equipment is cleaned and before its reuse.

Should unacceptable levels of contamination be discovered when a field blank is analyzed, then a method or System Blank is analyzed (see 2.6.2) to determine whether the problem can be ascribed to the sampling apparatus or to the analytical system.

2.6.2 System Blank (Method Blank)

A randomly selected sampling syringe is analyzed to determine whether interferences from syringes are present. If interference is found at unacceptable levels, another syringe is analyzed to determine whether the interference is due to the syringe or to the analytical system. Appropriate measures are taken to eliminate such interferences. A System Blank will be taken and analyzed at the end of each day's sampling.

2.6.3 Duplicate Samples

Duplicate soil gas samples are collected from each sampling location. Duplicate analyses are performed at least once every twenty field samples. Duplicate analyses must have relative percent differences (RPDs) of less than $\pm 20\%$.

2.6.4 Trip Blanks

An unused soil gas sample syringe is transported into the field with the sampling equipment. The trip blank syringe is handled in the same manner as a sample, but a sample is not collected through the trip blank syringe. If VOCs are detected in the blank, sample handling and transport procedures are subsequently reviewed.

2.6.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Matrix spikes can be performed by injecting a standard mixture into a loop in series with the sample loop and switching the valve to introduce both standard and sample simultaneously into the gas chromatograph. However, there is no point in performing a matrix spike because there can be no matrix effect (the sample matrix [gas] is injected along with the sample).

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2.6.6 Chromatographic Information

On the first page of each day's chromatograms, the following system parameters are noted:

- A) Gas flows for H₂, He, N₂, and air
- B) Tank pressures for H₂, He, N₂, and air
- C) Temperatures
 - 1. Injector
 - 2. Columns
 - 3. Detector
 - 4. Thermal small parts cleaner
- D) Integrator parameters
 - 1. Attenuation
 - 2. Peak markers
 - 3. Baseline offset
- E) Columns
 - 1. Type
 - 2. Length and diameter
 - 3. Packing material
 - 4. Temperature
- F) Operator
- G) Date

If any system parameters change, the changes are noted.

2.6.7 Internal Quality Control

All chromatograms are reviewed internally by a chemist other than the chemist performing the analysis.

2.6.8 Outside Quality Control Audits

Samples can be sent to independent laboratories for analysis as a quality assurance check as requested by clients. We do not in general advise that independent laboratory analysis be done. The quality assurance procedures outlined in this document conform in full to USEPA guidelines, which do not require separate laboratory confirmation.

2.6.9 Sample Chain of Custody

All samples are labeled with the following information:

- 1) Sample identification number
- 2) Date and time of sample collection
- 3) Name of sampler

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A field data/chain of custody form is completed for each sample. Figure 1 is an example of the chain of custody form, also called the Soil Gas Field Data Sheet.

At the time of sample collection, the field sampler fills out and signs the custody form. The sample is then transferred to the laboratory accompanied by the custody form, where the individual receiving the sample for analysis signs the original custody form and records the date and time. The chain of custody form (Soil Gas Field Data Sheet) is then filed in a notebook with the hard copy of the analytical results and eventually becomes part of the final report.

2.7 Procedures

Typical chromatographic equations are summarized in Section 2.7. The system is calibrated daily as described in Section 2.4.1.

2.8 Calculations

Each analyte in the sample chromatogram is identified by comparing the retention time of the suspect peak to retention times generated by the calibration standards on the appropriate detector. When applicable, the relative response of the alternate detector to the analyte is determined. The relative response should agree to within 20% of the relative response determined from the standards.

Quantitation is usually performed on the detector which exhibits the greater response if all detectors respond to an analyte. In cases where greater specificity or precision would result, the analyst uses his/her professional judgement in determining the alternate detector. In the case of co-elution, quantification is performed using either the detector that "sees" only one of the columns or by using the column and detector combination that does not exhibit co-elution.

The concentration of the unknowns is determined by using the calibration curve or by comparing the peak height or area of the unknowns to the peak height or area of the standards as follows for external standards:

$$C = (A/RF)(I/SA)$$

where

C = concentration of the analyte in sample in $\mu\text{g/L}$

SA = sample amount in L or kg

RF = relative response factor

Concentrations are reported in $\mu\text{g/L}$. The results are reported to the nearest $\mu\text{g/L}$ or if greater than 10 $\mu\text{g/L}$, to two significant figures.

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Chain of Custody Form

Page 12 of 12

HYDRO GEO CHEM, INC.
Field Data Sheet

Project Name: _____

Project No.: _____

Sample I.D.: _____

Probe Depth (ft): _____

Time Sampled: _____

Sampled by: _____

Date Sampled: _____

Check one: Soil Gas () Water () Soil ()

Field Parameters

Weather: _____

Ground Surface: _____

Air Temp (F): _____

Wind dir/speed: _____

Sample Parameters

Probe Volume (ml): _____

Max. Purge Vacuum (in. Hg): _____

Purge Volume (liters): _____

Equilibrium Time: _____

Purge Time: _____

Sample Volume (ml): _____

Notes: _____

Analytical Summary

Chemist: _____

Volume Analyzed (ml): _____

Date/Time: _____

Units: ug/l

Compound	Concentration		Compound	Concentration	
	A	B		A	B
Chloroethane	_____	_____	1,1,2-TCA	_____	_____
Chloroform	_____	_____	TCE	_____	_____
1,1-DCA	_____	_____	Vinyl Chloride	_____	_____
1,2-DCA	_____	_____	Benzene	_____	_____
1,1-DCE	_____	_____	Toluene	_____	_____
cis-1,2-DCE	_____	_____	Ethyl Benzene	_____	_____
trans-1,2-DCE	_____	_____	m/p-Xylene	_____	_____
Dichloromethane	_____	_____	o-Xylene	_____	_____
PCE	_____	_____	Freon-11	_____	_____
1,1,1,2-PCA	_____	_____	Freon-12	_____	_____
1,1,2,2-PCA	_____	_____	Freon-113	_____	_____
_____	_____	_____	_____	_____	_____
Surrogate Recovery	ELCD: _____ %	PID: _____ %	FID: _____ %	_____ %	_____ %

Figure 1. Example of Chain-of-Custody Form used by Hydro Geo Chem, Inc.



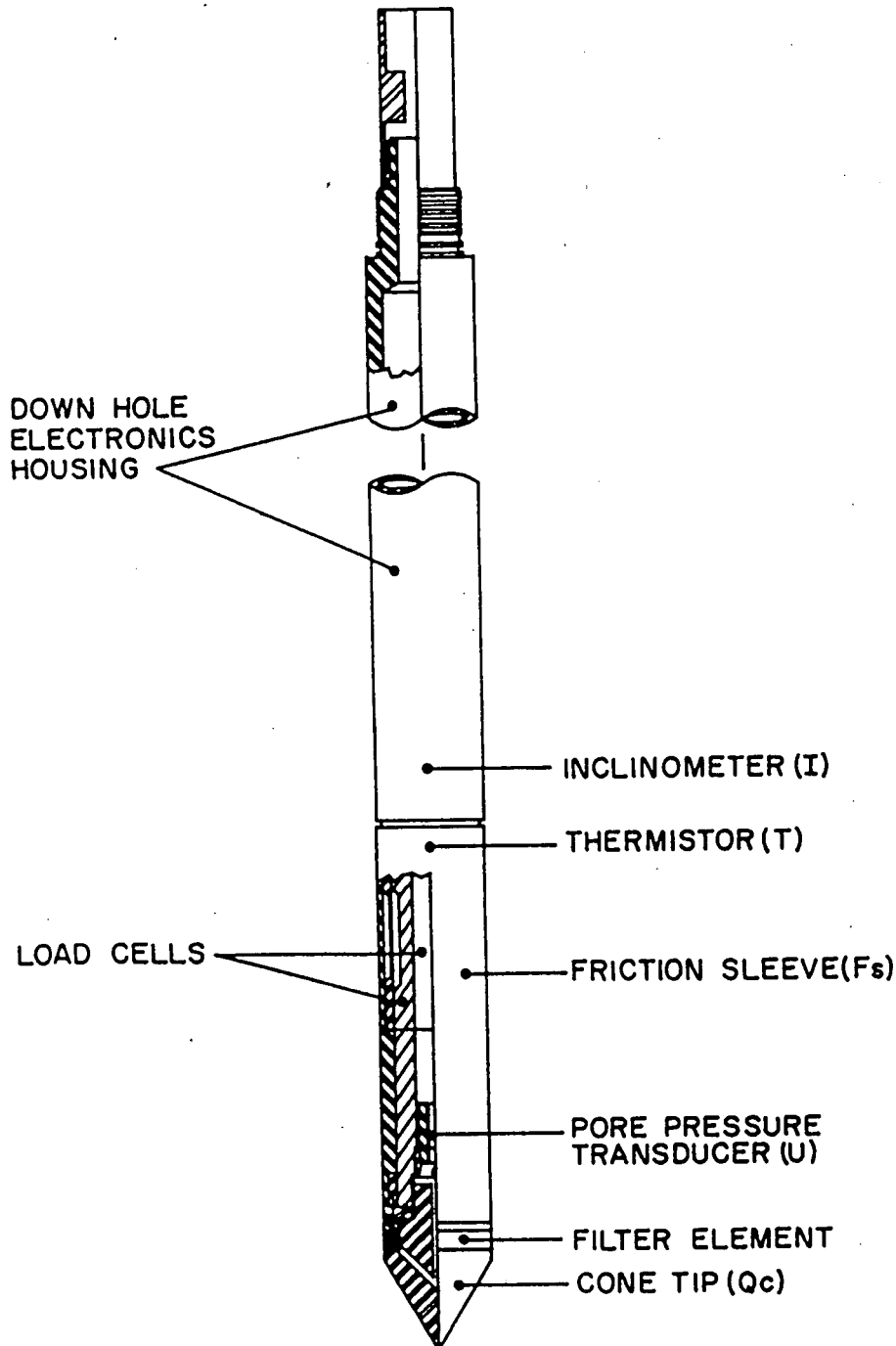
GREGG IN SITU TESTING, INC.

**In Situ Testing Services & Equipment
For Environmental & Geotechnical Applications**

SERVICES

- PIEZOCONE PENETRATION TESTING WITH BOTH 5 & 10 TON CONES
- SEISMIC CONE PENETRATION TESTING USING BOTH DOWNHOLE AND CROSSHOLE TECHNIQUES (P&S Wave Determination)
- RESISTIVITY CONE PENETRATION TESTING (Continuous Profile of Bulk Resistivity)
- GROUNDWATER SAMPLING SYSTEMS (Downhole samples from specific depths, returned to surface)
- GAS AND VAPOUR SAMPLING SYSTEMS
- SPT ENERGY CALIBRATION
- TEMPERATURE CONE PENETRATION TESTING (High Resolution Temperature Profiling of Soil & Water)
- VANE SHEAR TESTING
- SPECTRAL ANALYSIS OF SURFACE WAVES (SASW)
- INSTALLATION OF PUSH-IN PIEZOMETERS (Electric & Pneumatic)

PIEZO CONE PENETROMETER

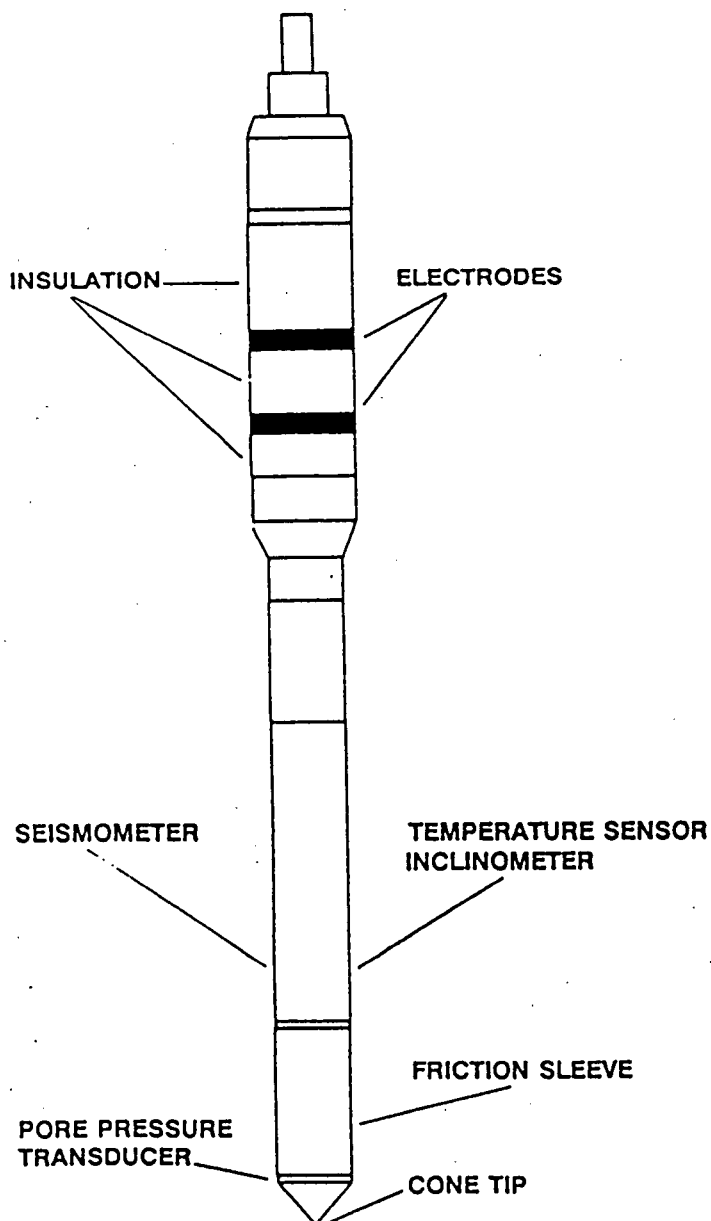


The electric piezocone (CPTU) is the premier soil logging tool. The CPTU provides a rapid, reliable and economic means of determining soil stratigraphy, relative density, strength and equilibrium groundwater pressures.

Gregg In Situ offers a choice of 2.5, 5, 10 and 15 ton tip (Q_c) capacity cones. Our cones also have variable capacity sleeve friction (F_s) and pore pressure (U). The pore pressure can be measured at one of 2 locations, either on the face of the cone tip or behind the cone tip. Pore pressure dissipation data is recorded automatically.

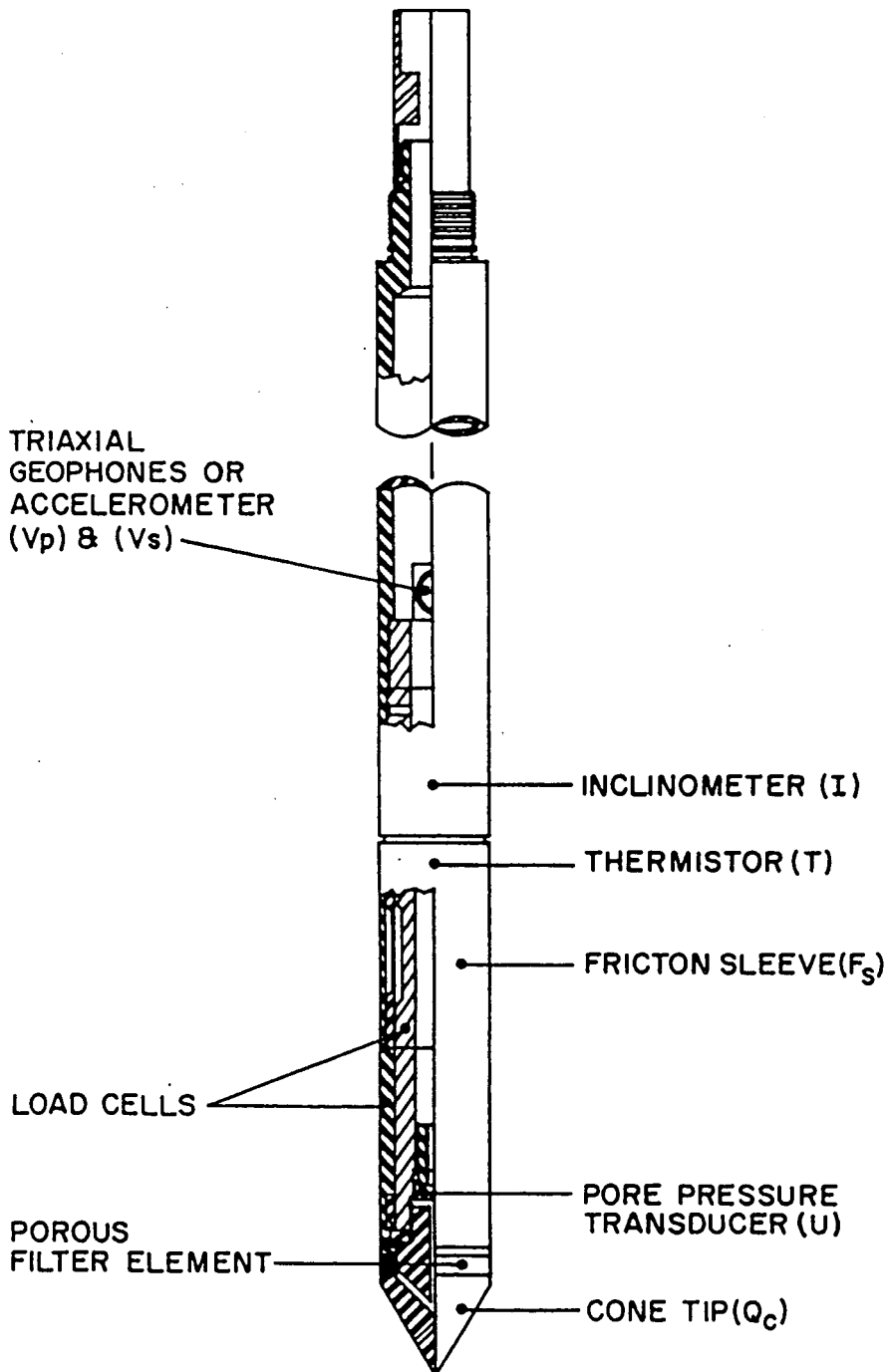
All data is displayed in real time at the ground surface, facilitating the on site decision making process. Field data reduction and plotting can be carried out on request.

ELECTRICAL RESISTIVITY CONE



The resistivity cone penetration test (RCPTU) combines the downhole analysis of soil resistivity and the logging capabilities of the cone penetration test (CPTU). The RCPTU provides a rapid, reliable and economic means of determining soil permeability, stratigraphy, and strength in addition to providing relative measurements of electrical resistivity. The ability to determine groundwater and soil resistivity and various other soil parameters in one operation on a near continuous basis allows for the accurate profiling of contaminated groundwater plumes as well as some estimate of the rate and direction of groundwater flow through the soil. Identification of the lateral and vertical extent of contaminants enables the engineer/scientist to rapidly implement a remedial works or recovery program thereby mitigating the potential damage caused by contaminated groundwater seepage. To the left is an illustration of Gregg In Situ's resistivity cone.

THE SEISMIC CONE PENETROMETER



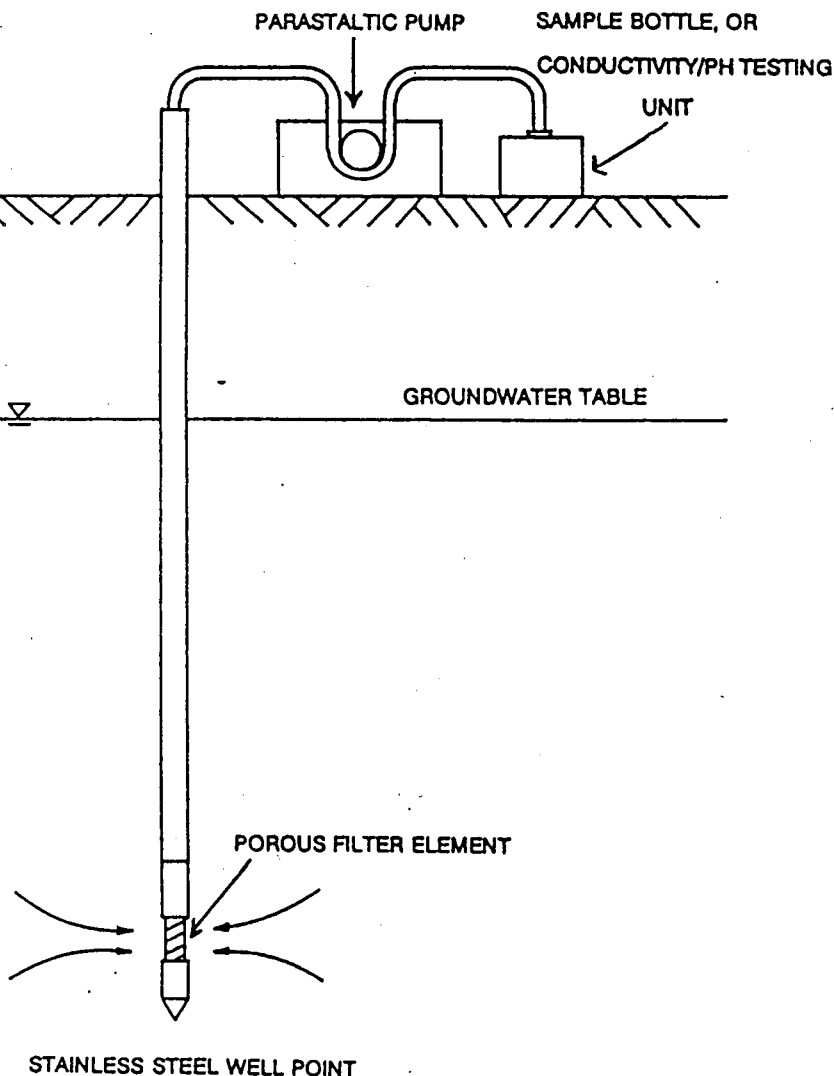
The seismic cone penetration test (SCPT) combines the seismic downhole method and the logging capabilities of the cone penetration test (CPT) to provide a rapid, reliable and economic means of determining soil stratigraphy, relative density, strength, shear and compressional wave velocities. From interval shear wave velocity (V_s) and the mass density (ρ) of a soil layer, the dynamic shear modulus (G_{max}) of the soil over a specific interval can be calculated according to the following expression:

$$G_{max} = \rho \times V_s \times V_s$$

The dynamic shear modulus (G_{max}) is a key parameter for the analysis of soil behaviour in response to dynamic loading from earthquakes, ice, vibrating machine foundations, waves and wind.

To the left is an illustration of Gregg In Situ's specially modified seismic cone penetrometer. Figure 1 on the overleaf shows the layout of the downhole seismic system. In addition to using a hammer as an energy source, shotgun shells and standard seismic caps may also be employed to generate seismic waves.

GROUND WATER AND VAPOUR SAMPLING SYSTEM



Our groundwater and vapour sampling systems provide a means of obtaining high quality groundwater and vapour samples.

Gregg In Situ offers three types of sampling systems:


1. Hydropunch
2. Bat
3. Our own uphole pumping system

Groundwater and/or vapour is collected by using a specially constructed stainless steel well point. There are two types of well points. One type allows for sampling at a single location. This well point is fully protected by a stainless steel outer sleeve thus preventing cross contamination from other soil layers and aquifers. The other type of well point does not have a stainless steel outer sleeve and allows for continuous sampling from specified depths throughout the entire soil profile.

BAT[®]

Groundwater Monitoring System

Unique technology
for ground water testing brings
the in situ conditions
into the laboratory.

- 
- Samples both liquid and gas phases
 - Usable in both saturated and unsaturated zones
 - Retains volatile components
 - Takes pressurized samples, even at great depths
 - Samples are encapsulated for easy and accurate lab analysis
 - No external contamination of samples, no human contact
 - Measures ground water pressure and soil permeability with reproducible accuracy
 - Usable in practically all soils, even impervious clay
 - Permits stratified sampling
 - Sampling and measurements are not impeded by sub-freezing surface temperatures
 - Long system life
 - Low level of investment per test site

BAT ENVITECH INC.

Geotechnical And Hydrogeological
Instrumentation

2134 Main St. Suite 145
HUNTINGTON BEACH, CA 92648
Phone (714) 969-6495

Sampling of ground water and gas

The BAT System provides the answer to most ground water monitoring problems in both the saturated and the vadose zones. It enables hundreds of test sites to be serviced by a single set of sampling and measurement probes.

Hermetically sealed system

All elements of the BAT System are hermetically sealed, ensuring no external contamination in the field, during transport or in the laboratory. Duplicate samples can easily be obtained, enabling analysis data to be verified.

Components

The BAT System for sampling of ground water contains three basic components:

- 1) A permanently installed, sealed filter tip attached to an extension pipe;
- 2) An evacuated and sterilized sample container of glass;
- 3) A disposable, double-ended hypodermic needle.

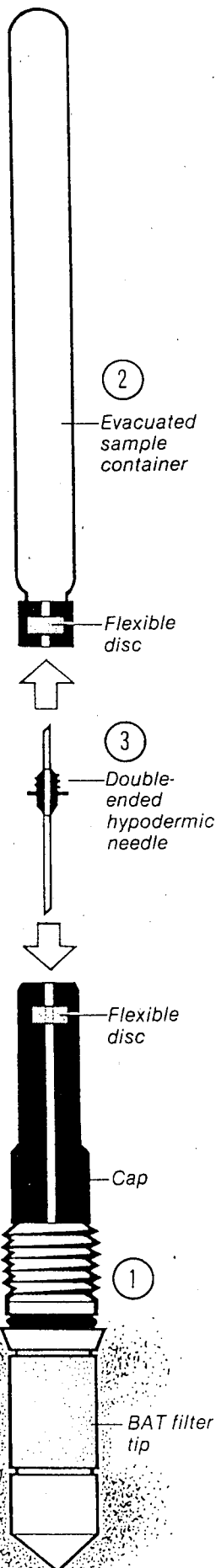
The filter tip is sealed with a specially developed flexible disc seated in its cap. The sample container is sealed in a similar manner.

Automatic quick-connect system

A temporary, leakproof hydraulic connection between the filter tip and the sample container is achieved by penetration of the hypodermic needle through the two flexible discs. Due to the underpressure in the evacuated container, ground water and/or gas is drawn via the filter tip into the container.

When the sample container is disconnected from the filter tip, the discs in both the filter tip and the container automatically reseal. The liquid and/or gas sample is thereby kept hermetically isolated all the way from the point of sampling and into the laboratory. The flexible disc in the filter tip can be pierced hundreds of times without loss of its automatic self-sealing capability.

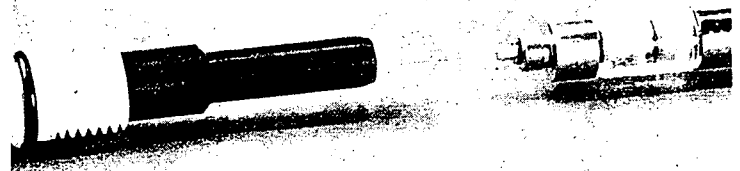
Since the sealed filter tip is in direct contact with the formation fluid, only a very small amount of fluid need be purged before each sample is taken.



Pressure measurements

Ground water pressure measurements are easily performed using a pressure probe lowered down the extension pipe. This probe consists of a flush diaphragm electric pressure transducer equipped with a hypodermic needle. The needle acts as a channel to equalize the pressure on the diaphragm with the actual ground water pressure around the filter tip.

Pressure readings are made using a handheld 4½ digit read-out unit. The unit is battery operated and has a resolution of 10 mm of water column. The BAT System measures both negative and positive ground water pressures. Standard measuring range is from -10 to 150 m of water column.

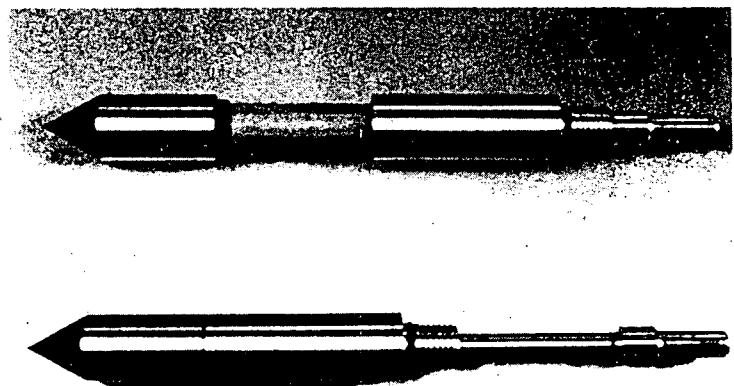


The pressure probe consists of a flush diaphragm electric pressure transducer equipped with a hypodermic needle. The needle provides a leakproof pressure connection between the transducer and the filter tip.

Permeability & tracer tests

Using the BAT System, in situ permeability (hydraulic conductivity) tests can be routinely performed.

The test is based on measurement of the rate of flow into or out of a sample container. This rate is computed by measuring the pressure change in the container, which using Boyle's law can be translated into a volume change. Analysis of the time-pressure record thus yields the coefficient of permeability.



Filter Tips, such as the Enviro Probe, shown here in the open and closed position are available in a range of sizes and materials for a broad range of applications.

HYDRO PUNCH™

Groundwater Sampling without Wells

The HydroPunch™ drastically reduces time and money spent on groundwater monitoring site assessments, by collecting samples without wells. Data can be used to determine vertical and horizontal extent of contamination, and to accurately quantify pollutant concentration.

Samples in as little as one hour

The HydroPunch (U.S. Patent No. 4,669,554) is easily used with cone penetrometer or conventional drilling equipment. It collects up to 500 ml of groundwater at the desired depth in unconsolidated soil, and under many conditions can be used to sample multiple water-bearing zones in one operation. The HydroPunch can be visualized as working like a "driven" bailer.

Save 70% or more on site assessment costs

Extremely cost-effective, the HydroPunch has proven in field use to cost as little as 1/10 the price of drilling, casing, and developing a conventional well. The HydroPunch can also help determine optimum location for dedicated wells when they are required. More effective placement can minimize the number of permanent wells needed, providing long-term savings.

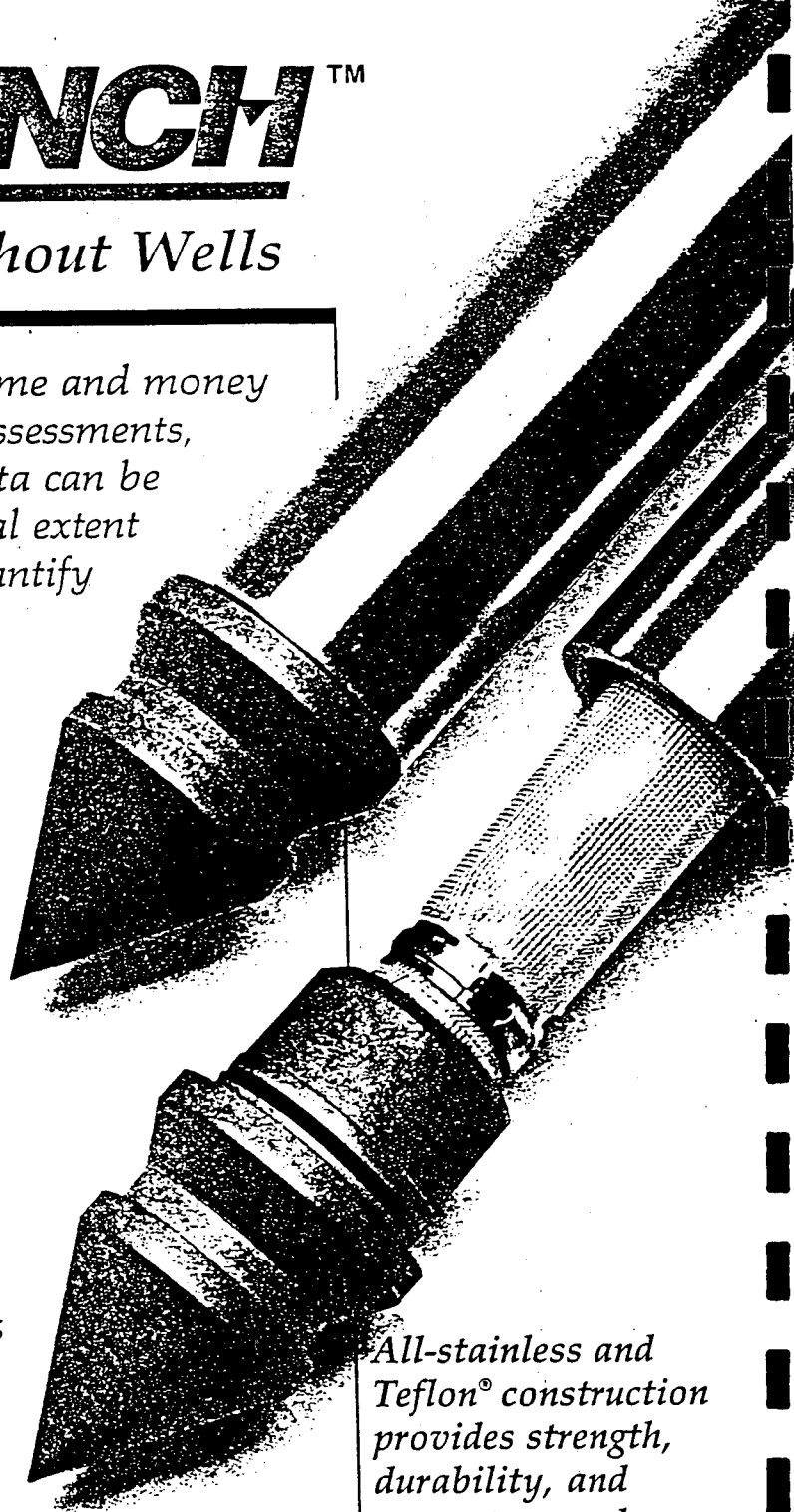
High-quality samples for accurate assessments

Samples are unaltered and uncontaminated by drilling fluids or cuttings. All-stainless and Teflon® construction makes the unit chemically inert, preventing contamination. In use, the HydroPunch is driven to the desired depth and then partially withdrawn, opening the inlet and isolating the collection zone from layers above and below. Replaceable inlet screen cartridges keep soil materials from entering the sample chamber.

HydroPunch samples are consistent with requirements for all priority pollutants, unlike indirect site assessment techniques (i.e., soil gas sampling or geophysical monitoring). Samples are not affected by changes in soil type or other complicating factors. Easy field cleaning expedites repetitive sampling.

Environmentally safe

The HydroPunch can be operated with minimal disturbance to environmentally sensitive areas. There's no need to dispose of well development water, or of contaminated drill cuttings when used with a cone rig. The technique is unobtrusive and won't interfere with normal site operations.



All-stainless and Teflon® construction provides strength, durability, and accurate samples uncontaminated by the testing procedure.

QED Environmental Systems, Inc.

INTRODUCTION

The HydroPunch™ is a stainless steel and Teflon® sampling tool. The HydroPunch provides a rapid, cost effective means to collect chemically representative ground water samples without the installation, development, and sampling of a ground water monitoring well. The resulting data can be used to help determine the vertical and horizontal extent of contamination and to accurately quantify the concentration of pollutants in the ground water. Ground water samples collected by the HydroPunch can be used to eliminate unnecessary ground water monitoring wells and to minimize the number of wells that are ultimately required for permanent ground water monitoring purposes. Savings of up to seventy percent (70%) of the cost of conventional well sampling have been reported.

Cost Comparison

Activity	Conventional Well Installation	HydroPunch with Penetrometer Rig	HydroPunch with Drill Rig
Mobilization	\$ 200	\$ 100	\$100
Drilling & Well Installation*	3,200	800	1,200
Well Development	500	—	—
Field Supervision	1,000	400	600
Sampling	600	425	425
Total Cost	\$5,500	\$1,725	\$2,325
Total Time	3 days	1 day	1.2 days

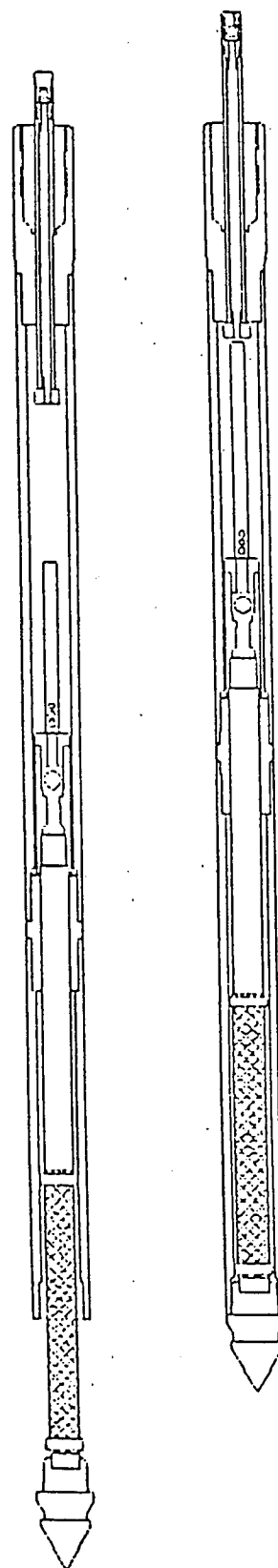
*Number of Groundwater Wells - 5

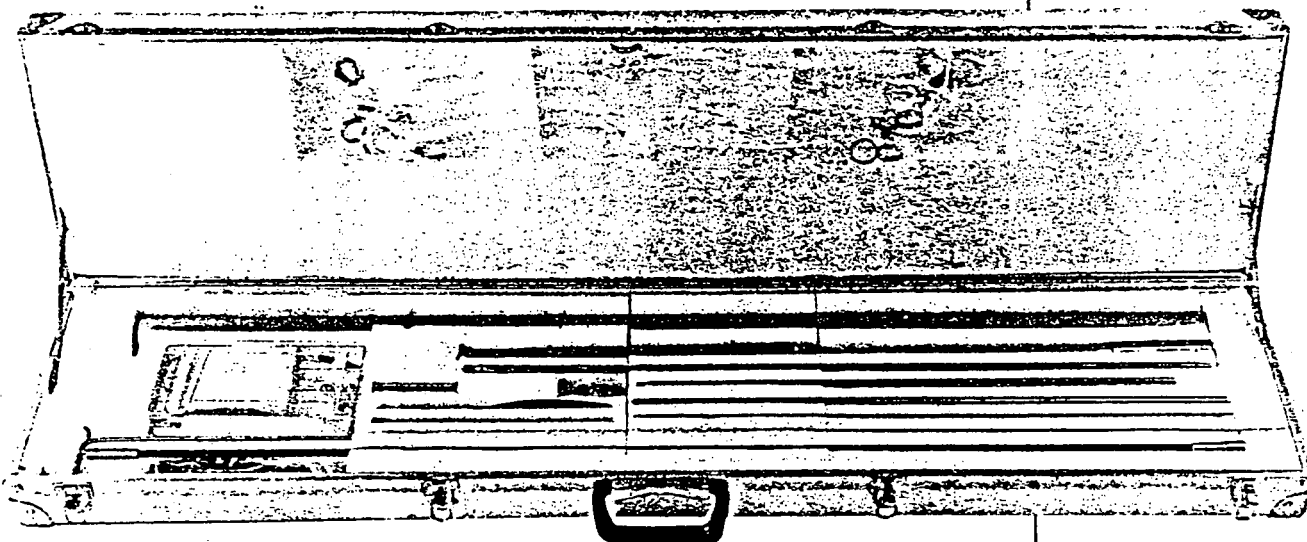
Depth to Groundwater - 25 feet

GENERAL TECHNICAL INFORMATION

The HydroPunch ground water sampling tool can be used in two modes, utilizing either cone penetrometer equipment or conventional drilling equipment to push or drive the tool to the desired sampling depth. The sampler is constructed entirely of stainless steel and Teflon, is easily cleaned in the field, and will collect approximately 500 ml of sample. The HydroPunch has a stainless steel drive point, a perforated section of stainless steel pipe for sample intake, a stainless steel and Teflon sample chamber, and an adapter to attach the unit to either penetrometer push rods or standard soil sampling drill rods.

As the unit is pushed or driven through the soil, the sample intake pipe is shielded in watertight housing that prevents contaminated soil or ground water from entering the unit. The shape of the sampler and its smooth exterior surface prevent the downward transport of the surrounding soil and liquid as the tool is advanced. When the desired sampling depth is reached, the sampler is retracted approximately 1.5 feet; the perforated intake pipe is exposed to the water-bearing zone, permitting ground water to flow through the screen and into the sample chamber. During sampling, no foreign materials (i.e., gravel pack, drilling fluid or cuttings) are introduced into the zone being sampled, minimizing the contaminants.





Specifications:

The HydroPunch™ is equipped with an "AW" box thread. Any sub-adapter or drive rod used with HydroPunch must have a minimum of 9/16" inside diameter by 4" deep above top of HydroPunch to allow clearance for top check. A number of adapters are available, allowing use of the HydroPunch with different types of drive rods.

The basic kit (shown above) includes one HydroPunch with barbed point in a sturdy, protective carrying case. The kit comes complete with water sample discharge device (w/Teflon® tubing and stopcock), cleaning brush set, extra O-ring and screen sets, extra stainless steel check balls, and all other accessories needed for use.

Maximum diameter: 1.75" Length: Closed—64.50" Open—76.50"

Weight (HydroPunch only): 24 lbs. Shipping weight: 44 lbs.

Sample volume: 500 ml (nominal)

*Complete HydroPunch
kit in heavy-duty
carrying case*

Guidelines for use:

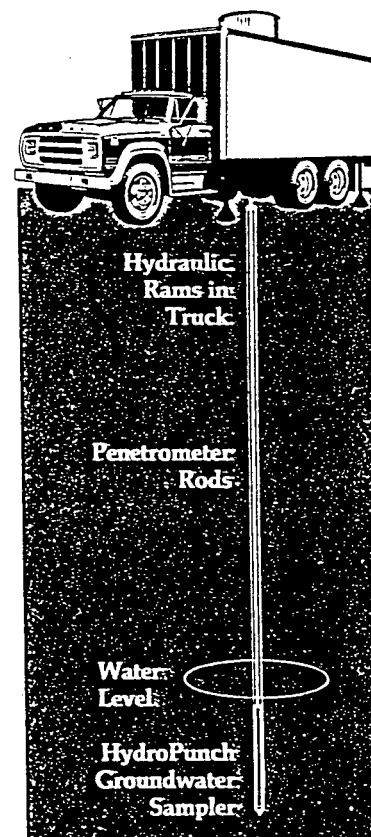
General applications

The HydroPunch is a groundwater sampling tool designed to be pushed or driven to the desired depth for sample collection. It is manufactured for durable performance, with rugged construction of stainless steel and Teflon®. Following a few basic guidelines will maximize the usable life of your HydroPunch.

In general, the HydroPunch can be pushed or driven into position in the same types of formations suitable for a standard 2" split barrel (spoon) soil sampler. Suitable geologic materials include unconsolidated clays, silts, sands, and fine gravels. Driving a split barrel sampler immediately above the desired HydroPunch sampling zone is helpful. This provides an estimate of soil permeability, and predicts the formation's resistance to driving the HydroPunch.

Hydrologic considerations

The HydroPunch fills using the aquifer's hydrostatic pressure, similar to the way a bailer fills; thus the formation thickness and yield determine the fill rate. The sample inlet area of the HydroPunch must be in hydraulic contact with a water-bearing zone to collect a sample. Because the sample chamber is above the inlet, the HydroPunch point must be driven to a minimum of 5 ft. below the static water level so that hydrostatic pressure is high enough to assure normal fill times and adequate sample volumes.

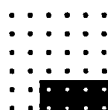


*Typical application using
HydroPunch with cone
penetrometer equipment.*

Appendix H



QA MANUAL

**BCA** *B C Analytical*

Preface to the Ninth Edition



This edition of the B C Analytical Quality Assurance Manual represents significant improvement over the Eighth Edition. Traditionally, we have drafted the manual to explain our quality program and procedures in detail to individuals outside BCA—clients, regulators, and auditors. While we recognize the importance of this audience, we also believe that the manual's primary value rests with rigorous, consistent use by all BCA bench analysts. Consequently, the authors have directed our attention to those readers in creating this document.

In the analyst's hands, the manual is intended to help meet client requirements, which means it must support compliance with applicable regulations. Many regulations apply to BCA's work; this manual draws most heavily on those required by the California Department of Health Services for certification under its Environmental Laboratory Accreditation Program (ELAP). Of the many method references available, the USEPA's SW-846 contributes the lion's share of guidance for our program. Naturally, we can also meet client requirements of greater or lesser rigor. Doing so requires that we supplement this manual with other documents, such as Quality Assurance Project Plans (QAPPs).

Although the QA Manual can stand on its own for some purposes, it is only a portion of BCA's comprehensive quality program. That program is best reflected in the BCA Quality Program Handbook, which is assigned to each analyst on the basis of work responsibilities. When presented as the first section of the handbook, this Ninth Edition serves to explain the quality-related policies that govern analytical work throughout BCA. The handbook's second section contains a set of Standard Operating Procedures (SOPs) appropriate to the individual analyst's assignment in the laboratory. An SOP, subject to more frequent revision than this manual, delineates the actual procedure to be followed for a specific laboratory process. The handbook's final section is devoted to specifications: the quality control and detection limits that determine compliance with agreed-upon requirements.

Responsibility for quality compliance begins with each analyst and ultimately resides with the laboratory director. The QA coordinators and the QA director have the authority

Preface

to interrupt any analytical process or withhold any result if out-of-control analysis occurs. BCA's commitment to total quality goes one step further—to the expectation of continuous improvement in all aspects of laboratory work.

Readers familiar with earlier editions of this manual will notice some structural changes. We have switched the format to ELAP's specified list of sections and away from the similar (but more repetitive) list in the USEPA's guidance document QAMS-005. We redesigned tables and formulas to improve readability. Changes in the quality program since the Eighth Edition resulted in our having more material to be covered here. To assure the manual's value to its primary readers, we deleted some of the text that had merely described the laboratories. We refer readers interested in a more general discussion of BCA's capabilities to two other BCA documents: our Statement of Qualifications and our annual User's Guide.

My co-authors and I hope this manual meets the needs of our readers. If you have any questions, please contact QA coordinators Barbara Bowman (at Emeryville) or Tom Kirk (at Glendale) or me (at BCA Admin, Glendale).

*Bob Peak, Director
BCA Quality Assurance Program
April 1993*

Section 1

QA Manual Title Page

Company B C Analytical

Locations Emeryville, Glendale, Anaheim
California

Quality Assurance
Program Staff

Robert Peak, Vice President, Quality Assurance Director


Thomas Kirk, Quality Assurance Coordinator, Southern California

Barbara Bowman, Quality Assurance Coordinator, Northern California

Edition Ninth

Publication Date April 1993

Approved by



S. Robert Peak
VP, QA Director



BCA B C Analytical

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Section 3 Organization and Responsibility

B C Analytical (BCA) operates four laboratory facilities at the following locations:

1200 Gene Autry Way,
Anaheim CA 92805

6121 Hollis Street,
Emeryville CA 94608

801 Western Avenue,
Glendale CA 91201

1255 Powell Street,
Emeryville CA 94608

The Emeryville laboratory includes two separate facilities but operates as a single unit. All samples are received at the Powell Street location.

3.1 Organization of Quality Program

3.1.1 Quality Assurance Staff Responsibilities

The Quality Assurance Director reports directly to the Chief Operating Officer and manages two BCA programs: quality assurance (QA) and information (computer) services.

QA Coordinators report to the QA Director and develop and carry out BCA's quality assurance systems. Their duties include: devising statistical procedures to establish and maintain control limits, maintaining laboratory certifications, issuing performance evaluation samples, updating standard operating procedures, hosting audits, and making appropriate recommendations for correction and improvement as necessary. They also seek out new ideas in the quality assurance field and present these ideas to staff and management as needed.

3.1.2 Operations Staff Responsibilities

The laboratory operations staff includes the operations manager, supervisors, chemists, scientists, and technicians. The manager is responsible for overall analytical operations, training programs, and safety plans. Supervisors are responsible for the duties of their analytical or functional section. Such duties may include: proper sample collection, sample preservation, and chain-of-custody; data review; staff training; turnaround time compliance; and sample archiving and disposal. Chemists, scientists, and technicians perform analyses following established methods and quality control requirements.

Client services representatives and project managers in all three laboratories are experienced in the environmental laboratory field and are trained to serve as liaisons

between lab operations and clients. They are responsible for understanding the client's data quality objectives and communicating these requirements to the operations staff.

3.1.3 Total Quality and the PMT

Total Quality, initiated at BCA in 1987 as Continuous Quality Improvement and strengthened in 1991, is an organization-wide approach to continuous improvement in quality, productivity, and participative management. At the heart of the structure is the employee-directed Process Management Team (PMT), which solicits opportunities for improvement from all staff members. The PMT evaluates these opportunities and, when appropriate, commissions a Quality Team of employees to solve and implement solutions to the improvement opportunities. The PMT monitors progress and keeps track of opportunities received, assists in forming teams, measures baseline data, and educates staff in Total Quality concepts.

3.2 Organization of Quality Program Documentation

3.2.1 Hierarchy of Quality Requirements

Policy The QA Manual sets forth the policies for quality assurance in all three labs.

Practices Standard Operating Procedures (SOPs) delineate laboratory practices. More detailed and subject to more frequent review than this manual, SOPs may vary from lab to lab, depending upon equipment variations and regional regulatory requirements.

Specifications Control limits and reporting detection limits are the specific criteria applied to quality control measurements. They are the basis for assessing analytical data quality.

3.2.2 QA Manual Format

To remove repetition, the format for the Ninth Edition of the QA Manual now follows that specified by the California Environmental Laboratory Accreditation Program (ELAP) instead of USEPA QAMS-005. This edition of the manual does meet all requirements of the QAMS-005.

Section 4 QA Objectives for Measurement Data

4.1 Project Data Quality Objectives as Input

The objective of B C Analytical's Quality Assurance Program is to ensure that we meet our clients' requirements in terms of data quality. Since data quality objectives (DQOs) often vary with individual projects, we set internal specifications that are strict enough to meet a majority of all client requirements. Project-specific DQOs can introduce greater or lesser rigor in QA requirements. Those specifications can be found in supplementary Standard Operating Procedures (SOPs) or Quality Assurance Project Plans (QAPPs).

4.2 Laboratory Data Quality Objectives

DQOs for analytical determinations are expressed in terms of precision, accuracy, detection limits, completeness, and comparability. Section 10.1 of this manual describes the types of quality control checks used to measure accuracy and precision and introduces the concepts of batch (prep) QC and run (instrument) QC.

At BCA, we determine statistical control limits for batch QC checks at a 99 percent confidence interval. Where method criteria are established, we require that our control limits be within those criteria. For example, accuracy limits are specified in several EPA methods for organic compounds. If statistical control limits fall outside the range allowed for in the method, we adjust them to reflect method limits. Tables of control limits and detection limits are printed in the Control Limits section of the BCA Quality Program Handbook. Calculations of these limits are described below.

We assess method capabilities by performing method detection limit (MDL) studies and by examining laboratory control standard (LCS) recoveries from historical batch data. Method objectives for precision, accuracy, and detection limits are listed in Table 4-1. These objectives are based on method and regulatory criteria, where available, and on interlaboratory comparisons of method capabilities in the three BCA labs. Using these objectives, we can determine whether the method is in control. A process that is not capable of meeting these criteria must be investigated to determine possible causes for bias or variability and then corrected.

Objectives for instrument QC checks are found in Section 7 and in the analytical SOPs referred to in Section 8.3. Data validation and corrective action procedures for outliers are described in Sections 9.2 and 14.1 and in BCA SOPs #QA01189 and #QA00789, respectively. Precision and accuracy assessment is discussed further in Section 13.

Table 4-1 PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

REREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (mg/L)
ME00288, ME00188, ME01088	METALS BY ICP AND FLAME AA			
	Aluminum	<10	90-110	0.1 a
	Antimony	<15	90-110	0.06 a
	Barium	<10	90-110	0.1 b
	Beryllium	<10	90-110	0.005 a
	Calcium	<10	90-110	5 a
	Cadmium	<10	90-110	1 c
	Chromium	<10	90-110	0.05
	Cobalt	<10	90-110	0.05 a
	Copper	<10	90-110	0.05 b
	Iron	<15	90-110	0.1 a,b
	Lead	<10	90-110	5 c
	Magnesium	<10	90-110	5 a
	Manganese	<10	90-110	0.01 a
	Molybdenum	<10	90-110	0.2
	Nickel	<10	90-110	0.04 a
	Potassium	<10	90-110	5 a
	Silver	<20	80-120	0.01 a,b
	Sodium	<10	90-110	5 a
	Thallium	<20	80-120	7 c
	Vanadium	<10	90-110	0.05 a
	Zinc	<10	90-110	0.02 a
ME01588	METALS BY GRAPHITE FURNACE AA			
	Aluminum	<10	90-110	0.1 b
	Arsenic	<15	85-115	0.01 a,b
	Antimony	<20	80-120	0.06 a
	Barium	<10	90-110	0.1 b
	Beryllium	<10	90-110	0.005 a
	Cadmium	<15	90-110	0.001 b
	Chromium	<15	90-110	0.01 a,b
	Cobalt	<10	90-110	0.05 a
	Copper	<15	90-110	0.02 a
	Lead	<15	90-110	0.005 a,b
	Molybdenum	<15	90-110	0.01
	Nickel	<10	90-110	0.04 a
	Selenium	<15	85-115	0.005 a,b
	Silver	<15	90-110	0.01 a,b
	Thallium	<15	90-110	0.01 a
	Vanadium	<10	90-110	0.05 a
ME01689	MERCURY BY COLD VAPOR			
	Mercury	<10	90-110	0.0002 a

Table 4-1 Cont'd PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

REREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (mg/L)
GE01289	ANIONS BY IC			
	Bromide	<10	90-110	1 a
	Chloride	<10	90-110	1 a,b
	Nitrate	<10	90-110	0.3 a
	Nitrite	<10	90-110	0.3 a
	Ortho-Phosphate	<10	90-110	1
	Sulfate	<10	90-110	1 a,b
	GENERAL CHEMISTRY			
GE00188	TDS	<10	90-110	10 a
GE00288	Phenolics	<10	90-110	0.05 a
GE00388	Cyanide	<10	90-110	0.01 a
GE00488	TSS	<10	90-110	5
GE00588	TOX	<10	90-110	0.02
GE00688	BOD	<10	90-110	7
GE00888	MBAS	<10	90-110	0.05 b
GE01088	Oil & Grease by IR	<10	90-110	1
GE01088	Petroleum Hydrocarbons	<10	90-110	1
GE01188	Ammonia Nitrogen	<10	90-110	0.1
GE01389	pH	<1	98-102	
GE01489	Turbidity	<2	95-105	0.1 b
GE01589	Conductivity	<3	95-105	
GE01689	Alkalinity	<2	95-105	10
GE01789	Sulfate	<10	90-110	2
GE01889	Oil & Grease, gravimetric	<10	90-110	5
GE01989	Silica	<10	90-110	1
GE02089	Phosphorus	<10	90-110	0.03
GE02189	Total Hardness	<5	95-105	2
GE02289	Hexavalent Chromium	<10	90-110	0.02
GE02389	Boron	<10	90-110	0.2
GE02791	Sulfide	<10	90-110	0.1
	Nitrate Nitrogen	<10	90-110	0.1
	Nitrite Nitrogen	<10	90-110	0.1
	Chloride	<5	95-105	1 a
	Residual Chlorine	<10	90-110	0.1
	COD	<10	90-110	10
	Fluoride	<10	90-110	0.1 b
	TOC	<10	90-110	1 a
	Flash Point	<5	95-105	

Table 4-1 Cont'd PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

RREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (µg/L)
GC00188	VOLATILE HALOCARBONS BY GC			
	Bromodichloromethane	<26 d	81-133 e	0.5 b
	Bromoform	<30	56-116	0.5 b
	Bromomethane	<30	40-99	0.5
	Carbon tetrachloride	<21	72-113	0.5 b
	Chlorobenzene	<23	71-117	0.5
	Chloroethane	<19	73-110	0.5
	2-Chloroethylvinylether	<35	65-135	0.5
	Chloroform	<17	74-108	0.5 b
	Chloromethane	<47	31-125	0.5
	Dibromochloromethane	<34	73-142	0.5 b
	1,2-Dichlorobenzene	<44	58-145	0.5
	1,3-Dichlorobenzene	<37	60-134	0.5
	1,4-Dichlorobenzene	<21	72-113	0.5 b
	1,1-Dichloroethane	<17	72-107	0.5
	1,2-Dichloroethane	<20	79-118	0.5 b
	1,1-Dichloroethene	<27	67-121	0.5 b
	cis-1,2-Dichloroethene	<25	75-125	0.5
	trans-1,2-Dichloroethene	<24	73-120	0.5
	1,2-Dichloropropane	<23	77-123	0.5
	cis-1,3-Dichloropropene	<32	68-132	0.5
	trans-1,3-Dichloropropene	<32	68-132	0.5
	Methylene chloride	<25	61-112	0.5
	1,1,2,2-Tetrachloroethane	<36	60-132	0.5
	Tetrachloroethene	<28	66-122	0.5
	1,1,1-Trichloroethane	<20	70-109	0.5 b
	1,1,2-Trichloroethane	<20	68-107	0.5
	Trichloroethene	<22	67-111	0.5 b
	Trichlorofluoromethane	<28	61-116	0.5
	Vinyl chloride	<28	67-123	0.5 b
GC00188	VOLATILE AROMATICS BY GC			
	Benzene	<23	72-118	0.5 b
	Chlorobenzene	<17	78-112	0.5
	1,2-Dichlorobenzene	<24	72-119	0.5
	1,3-Dichlorobenzene	<19	77-114	0.5
	1,4-Dichlorobenzene	<21	72-113	0.5 b
	Ethylbenzene	<26	70-122	0.5
	Toluene	<14	83-111	0.5
	Total Xylene Isomers	<25	75-125	2

Table 4-1 Cont'd PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

REREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (µg/L)
MS00188	VOLATILE ORGANICS BY GC/MS			
	Acetone	<30 d	70-130 e	10
	Acrolein	<40	60-140	50
	Acrylonitrile	<40	60-140	50
	Benzene	<19	84-122	1
	Bromodichloromethane	<25	70-120	1
	Bromoform	<25	81-131	1
	Bromomethane	<58	42-158	1
	Carbon tetrachloride	<13	89-115	1
	Chlorobenzene	<19	91-128	1
	Chloroethane	<44	78-166	1
	2-Chloroethylvinylether	<84	16-184	1
	Chloroform	<18	77-112	1
	Chloromethane	<57	37-151	1
	Dibromochloromethane	<20	81-120	1
	1,2-Dichlorobenzene	<29	87-145	1
	1,3-Dichlorobenzene	<16	98-131	1
	1,4-Dichlorobenzene	<29	87-145	1
	1,1-Dichloroethane	<19	87-126	1
	1,2-Dichloroethane	<20	84-124	1
	1,1-Dichloroethene	<48	67-163	1
	cis-1,2-Dichloroethene	<25	75-125	1
	trans-1,2-Dichloroethene	<21	84-126	1
	1,2-Dichloropropane	<45	55-145	1
	cis-1,3-Dichloropropene	<52	48-152	1
	trans-1,3-Dichloropropene	<34	66-134	1
	Ethylbenzene	<20	90-131	1
	Freon 113	<30	70-130	1
	2-Hexanone	<25	75-125	5
	Methylene chloride	<51	46-147	1
	Methyl ethyl ketone	<40	60-140	5
	Methyl isobutyl ketone	<30	70-130	5
	Styrene	<25	75-125	1
	1,1,2,2-Tetrachloroethane	<22	79-124	1
	Tetrachloroethene	<15	94-124	1
	Toluene	<15	93-123	1
	1,1,1-Trichloroethane	<21	89-131	1
	1,1,2-Trichloroethane	<19	85-122	1
	Trichloroethene	<17	99-132	1
	Trichlorofluoromethane	<32	69-133	1
	Vinyl chloride	<65	35-165	1
	Vinyl acetate	<40	60-140	10
	Total xylene isomers	<25	75-125	3

Table 4-1 Cont'd PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

REREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (µg/L)
GCO0588	ORGANOCHLORINE PESTICIDES BY GC			
	Aldrin	<16 d	69-101 e	0.04
	a-BHC	<20	67-107	0.03
	b-BHC	<17	64-99	0.03
	d-BHC	<23	62-107	0.03
	g-BHC	<19	60-99	0.03
	Chlordane	<15	67-97	0.3
	4,4'-DDD	<22	65-109	0.05
	4,4'-DDE	<21	71-113	0.04
	4,4'-DDT	<26	65-118	0.1
	Dieldrin	<23	68-114	0.03
	Endosulfan I	<22	77-121	0.05
	Endosulfan II	<43	53-140	0.05
	Endosulfan Sulfate	<24	61-109	0.1
	Endrin	<24	65-112	0.05
	Endrin aldehyde	<25	50-100	0.1
	Heptachlor	<16	56-86	0.03
	Heptachlor epoxide	<20	74-114	0.05
	Toxaphene	<17	66-101	1
	PCB-1016	<13	69-95	1
	PCB-1221	<33	64-130	1
	PCB-1232	<42	71-154	1
	PCB-1242	<23	72-117	1
	PCB-1248	<24	75-123	1
	PCB-1254	<21	59-101	1
	PCB-1260	<20	55-92	1
MS00288	SEMIVOLATILE ORGANICS BY GC/MS			
	Acenaphthene	<20 d	77-116 e	20 a
	Acenaphthylene	<23	67-113	20
	Anthracene	<21	60-102	20
	Benzo(a)anthracene	<23	65-110	20
	Benzo(b)fluoranthene	<27	64-119	20
	Benzo(k)fluoranthene	<30	55-116	20
	Benzo(a)pyrene	<30	60-120	20
	Benzo(ghi)perylene	<49	48-146	20
	Benzylbutylphthalate	<35	29-99	20
	Bis(2-chloroethyl)ether	<30	55-114	20
	Bis(2-chloroethoxy)methane	<30	77-137	20
	Bis(2-chloroisopropyl)ether	<26	74-127	20
	Bis(2-ethylhexyl)phthalate	<30	52-113	20
	4-Bromophenylphenyl ether	<15	75-105	20
	2-Chloronaphthalene	<12	77-101	20
	4-Chlorophenylphenyl ether	<27	65-119	20

Table 4-1 Cont'd PRECISION, ACCURACY, AND DETECTION LIMIT OBJECTIVES

RREFERENCE: BCA SOP#	ANALYSIS	PRECISION (% RSD)	ACCURACY (Mean % Rec)	MDL (µg/L)
SEMIVOLATILE ORGANICS BY GC/MS				
MS00288	Chrysene	<30	62-122	20
	Dibenzo(a,h)anthracene	<55	38-148	20
	Di-n-butylphthalate	<24	36-84	20
	1,2-Dichlorobenzene	<20	61-100	20
	1,3-Dichlorobenzene	<35	50-120	20
	1,4-Dichlorobenzene	<21	50-93	20
	3,3'-Dichlorobenzidine	<55	55-166	20
	Diethylphthalate	<23	21-67	20
	Dimethylphthalate	<21	1-42	20
	2,4-Dinitrotoluene	<20	67-107	20
	2,6-Dinitrotoluene	<20	83-122	20
	Di-n-octylphthalate	<29	46-104	20
	Fluoranthene	<22	60-104	20
	Fluorene	<12	78-102	20
	Hexachlorobenzene	<32	43-106	20
	Hexachlorobutadiene	<19	51-89	20
	Hexachloroethane	<13	59-85	20
	Indeno(1,2,3-cd)pyrene	<37	38-112	20
	Isophorone	<38	76-151	20
	Naphthalene	<23	55-100	20
	Nitrobenzene	<29	77-135	20
	N-Nitrosodi-n-propylamine	<47	59-153	20
	Phenanthrene	<13	74-100	20
	Pyrene	<13	71-97	20
	1,2,4-Trichlorobenzene	<20	73-113	20
	4-Chloro-3-methylphenol	<26	59-110	20
	2-Chlorophenol	<23	55-101	20
	2,4-Dichlorophenol	<20	67-106	20
	2,4-Dimethylphenol	<18	58-93	20
	2,4-Dinitrophenol	<53	10-116	20
	2-Methyl-4,6-dinitrophenol	<43	33-119	20
	2-Nitrophenol	<31	75-137	20
	4-Nitrophenol	<30	30-89	20
	Pentachlorophenol	<33	62-128	20
	Phenol	<16	28-60	20
	2,4,6-Trichlorophenol	<22	69-113	20

- Notes: a. Groundwater monitoring detection limit, Reference 4.3.1, Chapter Two, Table 2-15.
b. Drinking water detection limit, Reference 4.3.2.
c. Soluble threshold limit concentration, Reference 4.3.3.
d. Precision objectives calculated from Reference 4.3.1, methods 8010, 8020, and 8080, Table 4, and methods 8240 and 8270, Table 7, using equations for interlaboratory standard deviation, converted to percent recovery, 100S'/C.
e. Accuracy objectives calculated from Reference 4.3.1, methods 8010, 8020, and 8080, Table 4, and methods 8240 and 8270, Table 7, using $(100x'/T) + (100S'/T)$.

4.2.1 Precision

Precision is measured on each batch by the relative percent difference (RPD) between duplicate matrix spikes or, when matrix spikes are not feasible, between duplicate samples. The RPD is calculated as shown in Section 10. We assume that the relative precision is constant for concentrations greater than five times the RDL, and calculate statistical limits using a representative data set of 20 or more historical RPD measurements, when available. The formulas for these calculations are:

$$\overline{RPD} = (\sum RPD_i) / n$$

$$s_R = \sqrt{\frac{\sum RPD_i^2 - n\overline{RPD}^2}{n-1}}$$

where: \overline{RPD} = mean relative percent difference
 s_R = standard deviation of RPD measurements
 n = number of measurements (preferably 20 or greater)

The control limit is $\overline{RPD} + 3s_R$ and the warning limit is $\overline{RPD} + 2s_R$. Reference 4.3.4 contains further discussion of this technique.

Laboratory precision is measured over the long term for each method by the relative standard deviation of LCS recoveries. The objectives for this measurement are listed in Table 4-1. When these objectives are not met, the procedure is investigated to determine possible causes for variability, and corrective action is initiated to remove any causes found.

4.2.2 Accuracy

Accuracy is measured for each batch by the LCS and matrix spike recoveries. Accuracy is measured on each sample for gas chromatographic methods by recoveries of surrogate spike compounds. Percent recovery calculations are shown in Section 10. BCA establishes statistical limits for these parameters using a representative data set of 20 or more measurements, when available. The mean and standard deviation are calculated as follows:

$$\bar{x} = \frac{\sum x_i}{n}$$

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

Control limits are set at $\bar{x} \pm 3s$; warning limits at $\bar{x} \pm 2s$.

Laboratory accuracy is measured for each method over the long term by the average percent recovery of the LCS. The objectives for this measurement are listed in Table 4-1. If these objectives are not met, the procedure is investigated for possible sources of bias, and corrective action is initiated to remove any systematic causes found.

4.2.3 Detection Limits

Method detection limits (MDLs) are statistically determined for each instrument and method by analyzing seven low-level replicates as described in BCA SOP #QA00389.

Reporting detection limits (RDLs) are greater than or equal to the MDL. Objectives for this measurement are listed in Table 4-1.

Method blanks are analyzed with each batch to measure background. The control limit for the method blank is the RDL. If the method blank yields a negative result, the absolute value of the method blank should be below the RDL.

4.2.4 Completeness

Completeness is measured by determining the number of QC parameters that are in control for a given data set. Completeness objectives are applied during data review to distinguish between an out-of-control analytical process and an in-control process with random outliers or isolated out-of-control events. For this purpose, completeness is assessed at two levels.

Level I completeness is applied to individual batch QC parameters, such as LCSs and duplicate spike samples. When these parameters contain measurements of multiple analytes, evaluation of the data set typically leads to a mixture of in-control and out-of-control points. Level I completeness determines the overall control of the QC parameter, based on the same 99 percent confidence level used for individual analyte criteria.

For a QC parameter containing n analytes, each with a probability p' of being outside control limits, the probability P that c or fewer analytes will be outside control limits is given by the following equation:

$$P\{x \leq c\} = \sum_{x=0}^c \frac{n!}{x!(n-x)!} p'^x (1-p')^{n-x}$$

To determine the number of allowable outliers for a multi-component QC parameter to obtain 99 percent confidence, we substitute $P = 0.99$. Because the control limits for each individual analyte are determined at 99 percent confidence, the probability p' that any one will be out is 0.01. The following table was constructed using these values and a nomograph of the above equation.

# of analytes (n)	out-of-control analytes (c)
1-4	0
5-24	1
25-59	2
60-99	3
100+	4

In some cases statistical limits for individual analytes are wider than established method criteria. The more restrictive limits are imposed and the probability p' will be greater than 0.01. For these methods, the above criteria do not apply and the completeness objectives are determined on a case-by-case basis.

Other factors, such as data trending and the environmental significance of particular analytes, contribute to the evaluation of the QC parameter. These factors are discussed in Section 9.2.1.

Level II completeness is applied to the relationships between the QC parameters within a batch. The objective is a combination of all parameters in control. However, under some circumstances a batch containing out-of-control events may produce valid data. This level of assessment is discussed in Section 9.2.1.

4.2.5 Comparability

Comparability of results is measured through participation in interlaboratory performance evaluation studies. BCA measures the percentage of external check standards in range and keeps a six-month running average, as described in Section 11.2.4. The objective for each determination is to be within the tightest limits imposed by the organization performing the study. For example, in the EPA WP series studies, only results within the warning limits are considered in range. The objective for the six-month average is 90 percent.

4.3 References

- 4.3.1 *Test Methods for Evaluating Solid Waste*, United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, SW-846 Third Edition, September 1986, Revision 0.
- 4.3.2 Tamplin, B.R. and Baumann, F., Memorandum on Detection Limits for Purposes of Reporting, July 7, 1988.
- 4.3.3 *California Code of Regulations*, Title 22, April 1990, Division 4.5, Chapter 11, Article 2.
- 4.3.4 *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 17th Edition, 1989, Section 1020 B.

Section 5 Sampling Procedures

Assuring the quality of environmental data begins in the field at the time of sample collection. Experienced field personnel, appropriate sampling equipment, rigorous sampling procedures, and quality control checks are essential to producing quality data. B C Analytical provides trained staff for sample collection purposes through the Field Services Department. Proper sampling includes using appropriate equipment, containers, and preservation as well as following strict procedures for collection, storage, and transport to prevent loss of sample integrity.

5.1 Containers and Preservatives

BCA provides appropriate containers and preservatives to clients who choose to perform their own sampling. To assure selection of the proper container and application of the appropriate preservative, our staff refer to EPA guidelines published in the *Federal Register*, 40 CFR Part 136.3, July 1, 1987. BCA makes this information available to clients in the form of "Table Z," a pocket-sized reference sheet that is shown here as Table 5-1. We purchase containers, such as vials for volatile organics, amber bottles pretreated for organic priority pollutant analysis, and others from suppliers who perform quality control checks to demonstrate compliance with EPA's "Specifications and Guidance for Obtaining Contaminant-Free Sample Containers," April 1990. Containers for microbiology are purchased pre-sterilized or are sterilized in house prior to use.

Preservatives are prepared from chemicals that are of analytical reagent grade or better. Preservatives are added to sample containers prior to sampling or shipping to the sampling team. Proper preservation is verified when the samples arrive at the laboratory. If samples are improperly preserved, adjustments are made and documented. If the sample integrity is compromised, the client is notified so arrangements can be made to collect a new sample.

Table 5-1 PRESERVATIVES, BOTTLES, AND HOLDING TIMES
DEPARTMENT: ORGANICS

ANALYSIS	COMPUTER CODE	HOLDING TIME	PLASTIC/ GLASS/BRASS	CUSTOMARY AMOUNT	MINIMUM AMOUNT	PRESERVATION
Chlor. Benzene	CHC.612/8120	∞	G (amber)/B	2L/1 core	1L	Cool 4°C
Chlor. Herbicides	HRB.615/8150	∞	G (amber)/B	2L/1 core	1L	Cool 4°C
DBCP	DBCP	14 days	G (amber)/B	2L/1 core	1L	Cool 4°C
EDB	EDB	∞	G (amber)/B	2L/1 core	1L	Cool 4°C
Volatile Hydrocarbons	5030.TPHG	7 days (14 days if acidified with HCL)	G (Teflon)/B	2x40 ml/1 core	40 ml/1 core	Cool 4°C
Semivolatile Hydrocarbons	3510/3550.TPH	∞	G(amber)/B	2L/1 core	1L	Cool 4°C
Calderon	CALDERON.LAND	72 hours	Tedlar bag	10 L	8L	None
Fixed Gases	FIXED.GASES	14 days	Ted. bag / bombs	1L	1L	None
Organochlorine Pesticides (and PCB)*	PEST.608/8080/TICH	∞	G (amber)/B	2L/1 core	1L	pH5 - pH9
Phenols	PHS.604/8040	∞	G (amber)/B	2L/1 core	1L	Cool 4°C
Polynuclear Aromatics*	PNA.610/8100/8310	∞	G (amber)	2L	1L	Cool 4°C
Halogenated Volatile Organics	VH.601/8010	14 days	G (Teflon) G (Teflon)/B	2 x 40 ml 2 x 40 ml/1 core	40 ml 40ml/1 core	Cool 4°C Cool 4°C
Volatile Organics*	VOA.624/8240	14 days	G (Teflon) G (Teflon)/B	2 x 40 ml 2 x 40 ml/1 core	40 ml 40 ml/1 core	Cool 4°C + HCl NaHSO ₄
Purgeable Aromatics*	VA.602	7 days (14 days if acidified with HCL)	G (Teflon)	2 x 40 ml	40 ml	Cool 4°C
Aromatic Volatile Organics	VA.8020	14 days	G (Teflon)/B	2 x 40 ml/core	40 ml/1 core	Cool 4°C + HCl NaHSO ₄
Tribaloromethanes	THM	14 days	G (Teflon, amber)	2 x 40 ml	40 ml	Cool 4°C Na ₂ S ₂ O ₅
Semivolatile Organics*	BNA.625/8270	∞	G (amber)/B	2L/1 core	1L/1 core	Cool 4°C
Carbamates	632	∞	G (amber)	2L	1L	Cool 4°C
Formaldehyde	FORMALDEHYDE	72 hours	G (amber)	2x250 ml	250 ml	Cool 4°C

DEPARTMENT: METALS

ANALYSIS	COMPUTER CODE	HOLDING TIME	PLASTIC/ GLASS/BRASS	CUSTOMARY AMOUNT	MINIMUM AMOUNT	PRESERVATION
Metals, Total pH < 2, HNO ₃		6 months	PVG/B	1L/25g	500 ml/5 g	
Metals, Dissolved		6 months	PVG/B	1L/25g	500ml/5 g	Filter in field (or Immud.), 0.45 micron, pH < 2, HNO ₃
Hexavalent Chrom.	CR, VI	24 hours	PVG/B	100 ml/5 g	20 ml/1 g	Cool 4°C
Mercury	HG	28 days	PVG/B	500 ml/5 g	100 ml/1 g	pH < 2, HNO ₃
Pb, Organic	PB,ORG	N/A	PVG/B	500 ml/25 g	100 ml/1 g	None

DEPARTMENT: MICROBIOLOGY AND BIOASSAY

ANALYSIS	COMPUTER CODE	HOLDING TIME	PLASTIC/ GLASS/BRASS	CUSTOMARY AMOUNT	MINIMUM AMOUNT	PRESERVATION
Algae, Phyto	PHYTO	24 hours / 1 month	PVG	120 ml	20 ml	Cool 4°C / Formalin
Coliform, Total Coliform, Fecal Strept	COLLT COLL, F	6 hours, surface, recreational water; 30 hours drinking water	PVG (sterile)	120 ml	120 ml	Cool 4°C
Plate Count	PLATE.CT	24 hours	PVG	120 ml	20 ml	Cool 4°C
Bioassay (NPDES)	BIOA.SOL.BEN BIOA.LC50/BIOA.S	24 hours	PVG	5 gal per fish species	5 gal	Cool 4°C
Bioassay (HAZ WASTE)	BIOA.HAZ.SCREEN BIOA.HAZ.LC50	N/A	PVG	250 g	250 g	Cool 4°C

* Add Na₂S₂O₅ if sample is chlorinated water supply ∞ 7 days (aqueous) 14 days (nonaqueous) to extraction

Table 5-1 (cont'd) PRESERVATIVES, BOTTLES, AND HOLDING TIMES

DEPARTMENT: GENERAL CHEMISTRY

ANALYSIS	COMPUTER CODE	HOLDING TIME	PLASTIC/ GLASS/BRASS	CUSTOMARY AMOUNT	MINIMUM AMOUNT	PRESERVATION
Acidity	ACIDITY	14 days	PVG	100 ml	20 ml	Cool 4°C
Alkalinity	ALK	14 days	PVG	100 ml	20 ml	Cool 4°C
BOD	BOD5	48 hours	PVG	500 ml	500 ml	Cool 4°C
Boron	B	6 mo	P	20 ml	20 ml	None
Bromide	BR	28 days	PVG	100 ml	20 ml	None
COD	COD	28 days	PVG	100 ml	20 ml	Cool 4°C pH < 2, H ₂ SO ₄
Chloride	CL	28 days	PVG	250 ml	50 ml	None
Chlorine Residual	CL2	Analyze immediately	PVG	250 ml	100 ml	Cool 4°C
Chlorine Demand	CL2DEM	Analyze immediately	PVG	250 ml	100 ml	Cool 4°C
Chlorophyll	CHLOROPHYL	8 hours / 1 month	PVG	100 ml	20 ml	Cool 4°C / Freeze
Color	COLOR	48 hours	PVG	100 ml	50 ml	Cool 4°C
pH	PH	Analyze immediately	PVG	100 ml	20 ml	Cool 4°C
Cyanide	CN	14 days	PVG	1 L	500 ml	Cool 4°C pH > 12, NaOH
Fluoride	F	28 days	P	100 ml (300 ml for ww)	50 ml	None
Hardness	HARD, T	6 months	PVG	100 ml	20 ml	pH < 2, H ₂ SO ₄ HNO ₃ / H ₂ SO ₄
Nitrogen Ammonia	NH3-N	28 days	PVG	500 ml (300 ml for ww)	100 ml	Cool 4°C pH < 2, H ₂ SO ₄
TKN	TKN	28 days	PVG	500 ml (300 ml for ww)	100 ml	Cool 4°C pH < 2, H ₂ SO ₄
Nitrate	NO3-N	48 hours	PVG	100 ml	20 ml	Cool 4°C
Nitrite	NO2-N	48 hours	PVG	100 ml	20 ml	Cool 4°C
Nitrate + Nitrite	NO3 + NO2	28 days	PVG	100 ml	20 ml	Cool 4°C pH < 2, H ₂ SO ₄
Odor	ODOR	6 hours	G (deodorized)	1 L	1 L	Cool 4°C
Oil and Grease	O & G	28 days	G	2 L	500 ml	Cool 4°C pH < 2, H ₂ SO ₄
Petroleum EC	PETROHC	28 days	G	2 L/60g	500 ml/20g	Cool 4°C pH < 2, H ₂ SO ₄
Phenols	POH	28 days	G	1 L	500 ml	Cool 4°C pH < 2, H ₂ SO ₄
Phosphate, Total	PO4	28 days	PVG	50 ml	20 ml	Cool 4°C pH < 2, H ₂ SO ₄
Phosphate, Ortho (Filter on site/immed.)	ORTHO-P	48 hours	PVG	50 ml	20 ml	Cool 4°C
Salinity	SALINITY	28 days	PVG	100 ml	20 ml	None
Silica	SiO2	28 days	P	50 ml	20 ml	Cool 4°C
Solids, Total	TS	7 days	PVG	250 ml	100 ml	Cool 4°C
Solids, Volatile	VS	7 days	PVG	250 ml	100 ml	Cool 4°C
Solids, Total Suspended	TSS	7 days	PVG	250 ml	100 ml	Cool 4°C
Solids, Total Dissolved	TDS	7 days	PVG	250 ml	100 ml	Cool 4°C
Solids, Settleable	SETT	48 hours	PVG	1 L	1 L	Cool 4°C
Specific Conduct.	COND	28 days	PVG	120 ml	50 ml	Cool 4°C
Sulfate	SO4	28 days	PVG	120 ml	50 ml	Cool 4°C
Sulfide	S2-	7 days	PVG	500 ml	250 ml	Zn Acetate + Na OH, pH > 9
Sulfite	SO3	Analyze immediately	PVG	250 ml	50 ml	Cool 4°C
Surfactants	MBAS	48 hours	PVG	500 ml	250 ml	Cool 4°C
Total Organic Carbon	TOC	28 days	PVG	40 ml	20 ml	Cool 4°C, pH < 2, H ₂ SO ₄ , or HCL
Total Organic Halogens*	TOX	28 days	G (amber) No headspace	250 ml	125 ml	Cool 4°C pH < 2, H ₂ SO ₄
Turbidity	TURB	48 hours	PVG	100 ml	20 ml	Cool 4°C
Gross Alpha/Beta Radioactivity	RAD	6 months	PVG	1 L	500 ml	pH < 2, HNO ₃

5.2 Procedures

Field sampling procedures are documented in the Brown and Caldwell "Hazardous Materials Field Procedures Manual" and in the following BCA Standard Operating Procedures:

- FS00190 Groundwater Sampling
- FS00791 Sampling Drinking Waters for Microbiology
- FS00892 Wastewater Sampling

These documents list the equipment and procedures required for field decontamination as well as the safety considerations and common analytical measurements taken at the time of sampling. Field services personnel are available to clients for on-site training in sampling procedures and guidance on regulatory requirements for environmental sampling.

5.3 Equipment

A complete listing of sampling equipment is printed in the Field Services section of the BCA Fee Schedule. Sampling equipment is also available to clients for rental.

5.4 Documentation and Holding Times

Sample custody procedures begin when the sample is collected. Documentation must include a specific description or identification of the sample, the time and date of sample collection, location, matrix type, analyses required, and identification and affiliation of the collector. This information will help ensure that all analyses are performed within method-specified holding times. Holding times for aqueous samples are listed in Table 5-1. A completed chain-of-custody form must accompany all samples, whether delivered to the laboratory, picked up by a BCA courier, or sent by common carrier.

5.5 Field QC

Field quality control (QC) samples are taken as required by the individual project. Triple volume is taken for one out of each batch of samples to be used by the laboratory for duplicate spike determinations. Other field QC samples may include trip blanks, equipment rinse blanks, field duplicates, or field spikes.

Organic-free water is prepared in the laboratory for trip blanks. Each lot is numbered and tested before use, and the test results are kept on file to ensure that no contaminated trip blanks are sent to the field.

Section 6 Sample Custody

To produce legally defensible data, BCA must maintain and demonstrate custody control of samples. Two components of custody must be addressed: physical possession and documentation of access. Beginning with appropriate field records produced and maintained by the client, a custody record proceeds through sample receipt at the laboratory, possible transfer of the sample(s) to another BCA facility, and distribution of samples or aliquots to analytical stations. Each level has requirements for physical possession and document handling.

6.1 External Transfer

The field scientist creates the initial records in the custody trail: filling sample containers, labeling them, and completing a chain-of-custody (COC) document describing them. The COC includes the date and time of sampling, sample descriptions, sampling locations, matrix types, identification and affiliation of the sample collector, and required analyses. Clients often use BCA's COC form (Figure 6-1), but may have a customized form of their own.

If samples are brought to the laboratory without a COC, a BCA Sample Receipt staff member asks the client to fill one out before the transfer of possession. When a COC is complete, the client signs and dates it to release the samples and the Sample Receipt staff member signs it to accept them. Specific instructions regarding the receipt of samples and custody procedures are detailed in SOP #SA00188.E (for Emeryville) and #SA00589.G (for Anaheim and Glendale). To demonstrate that no tampering has occurred after sample collection, some clients attach custody seals (Figure 6-2) across the container openings.

Sample Receipt personnel must note on the COC any discrepancies between the physical samples and the custody record. Among features examined are:

- a. The samples are clearly marked and dated
- b. Samples were collected in appropriate containers and volumes
- c. Samples have been properly preserved (when needed and verification is feasible)
- d. The samples are in good condition and custody seals (if used) are intact
- e. The COC record matches the sample numbers and descriptions

Once the COC is signed, a copy of it is provided to the client. Each sample is assigned a unique laboratory ID number and logged into the bound Sample Receiving Log Book. Key characteristics are recorded in the book, and a full work description is logged into the computer-based Laboratory Information Management System (LIMS). Labels with the

CHAIN OF CUSTODY RECORD

8CA Log Number

[illegible]**BC ANALYTICAL**

- ☐ 1255 Powell Street, Emeryville, CA 94608 (510) 428-2300
☐ 801 Western Avenue, Glendale, CA 91201 (818) 247-5737
☐ 1200 Gene Autry Way, Anaheim, CA 92805 (714) 978-0113

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.

Disposal arrangements: _____

*KEY: WW—Wastewater SU—Surface Water SO—Soil
SL—Sludge PE—Petroleum GW—Groundwater
NA—Nonaqueous AQ—Aqueous OT—Other

NA—Nonaqueous AQ—Aqueous OT—Other

Figure 6-1 B C ANALYTICAL CHAIN-OF CUSTODY FORM

Figure 6-2 CUSTODY SEAL

CUSTODY SEAL		<i>B C Analytical</i>		
Sample ID		1255 Powell St. Emeryville, CA 94608 (415) 428-2300	891 Western Ave. Glendale, CA 91201 (818) 247-5737	1200 Gene Autry Way Anaheim, CA 92805 (714) 978-0113
Client	Date			

sample ID numbers are printed from the LIMS and attached to the containers to assure proper handling and distribution. The log-in record is printed as well, serving as both a work acknowledgement and a record of receipt.

The laboratory copy of the COC is attached to the original of the work acknowledgement (called the "traveller"). The two forms reside together in a "suspense" caddy throughout the time analysis is under way. Following analysis, the final report is matched with the traveller-COC and given to the project manager or client services representative for review and approval. Once approved, the report is sent to the client. A copy, with the traveller-COC attached, is filed by client name for long-term archiving.

6.2 Transfers Between BCA Facilities

Two types of custody records are used to manage the exchange of samples within the BCA system. At Emeryville, with its two facilities, all samples (under appropriate custody control) are received at the Powell Street location. Some samples or splits are then transported two blocks away for analysis at the Hollis Street location. For these custody transfers, the sample manager uses the BCA Internal Chain-of-Custody form found in SOP #SA00689.E, Sample Distribution—Emeryville.

Other internal transfers include sending all or part of an analytical order to a different BCA laboratory. In that case, the lab that initially receives the job logs it in (under appropriate custody), prints out a work acknowledgement, and stamps that printout with an internal COC panel. A lab representative fills out this COC panel and then sends the printout with the sample(s) to the other lab, which verifies the information and signs the COC panel. When the samples are logged in at the second lab, the internal-transfer COC is attached to a new traveller and becomes part of the permanent record.

6.3 Internal Tracking and Access Control

Early in 1992, a Quality Team at the Anaheim laboratory developed a manual system for recording distribution of sample fractions and aliquots within the laboratory. With that task complete, a new team was convened to automate sample tracking and access control on a pilot basis in the Glendale lab. When systems have been designed, installed, and fully tested, we expect to automate internal custody records throughout BCA.

The manual systems currently in use are described in SOP #SA00689.G, Sample Distribution—Glendale; SOP #SA00689.E (described above); and SOP #SA00889.E, Sample Archiving.

The most rigorous of the manual systems serves as the model for automation. Individual sample containers are assigned sub-sample numbers, coded as fractions, splits, or pour-offs. These containers are all recorded as received in the main Sample Receipt area. A record is also made when individual containers are transferred to specific analytical-area storage refrigerators. While the samples are undergoing actual analysis, the date, time, and analyst's initials are recorded in the prep log or run log to document analytical sample custody. A final record is made when samples are removed from storage areas and transferred to the sample disposal station. After that, samples are no longer considered "in custody" and are not suitable for reanalysis, even if still physically present. Disposal practices, including return to the client (under custody control if required), are addressed in SOP #SA00991.G and #SA00991.E.

Section 7 Calibration Procedures and Frequency

7.1 Standard Materials

All reagent chemicals B C Analytical uses are of ACS reagent grade or better, purchased from reputable laboratory supply companies. Standards are prepared in house from high-purity starting materials or purchased as stock solutions. Where available, calibration standards are prepared from starting materials that are certified traceable to National Institute of Standards and Technology (NIST) standard reference materials (SRMs). In some cases, the NIST SRMs are purchased directly.

Each analytical run, all calibration standards are checked against a second source control standard or calibration verification standard. Comparability studies are carried out frequently to validate the concentrations of the calibration standards used.

Documentation is kept on all purchased and prepared standard materials according to BCA SOP #QA01289. This information is referenced on container labels and in log books for sample preparation and analysis to provide internal traceability on all standards.

7.2 Procedures, Frequency, and Acceptance

Calibration procedures differ by analytical method. The BCA SOPs referenced in Section 8.3 contain information on the calibration procedures, frequency requirements, and acceptance criteria for each method. These are summarized below. Project-specific data quality objectives can introduce greater or lesser rigor in calibration requirements. Those specifications can be found in supplementary SOPs or QAPPs.

7.2.1 Volatile Organics by GC/MS

Instrument tune is checked with BFB (bromofluorobenzene) every 12 hours of operation. Retention time, peak area and shape, sensitivity, and isotope ratios are examined. A mass calibration is performed with perfluorotributylamine as needed when the instrument is tuned.

Initial calibration of the GC/MS is conducted as required to meet continuing calibration criteria using five concentrations. Response factors of five system performance check compounds (SPCCs) and six calibration check compounds (CCCs) are examined. SPCC response factors should exceed 0.300 (Exception: 0.250 for bromoform). The percent relative standard deviation of the CCC response factors should be less than 30 percent.

A continuing calibration check is run every 12 hours. The SPCC response factors should meet the same criteria as in the initial calibration, and the CCC response factors may not deviate more than 25 percent from the average response factor of the initial calibration.

The internal standard calibration method is used to quantitate samples. Internal standard area counts in any sample must fall between 50 and 200 percent of the internal standard area in the continuing calibration for that run.

7.2.2 Base/Neutral and Acid Extractable Organics by GC/MS

Instrument tune is checked with DFTPP (decafluorotriphenyl phosphine) every 12 hours of operation. Sensitivity and isotope ratios are examined. A mass calibration is performed with perfluorotributylamine as needed when the instrument is tuned.

Initial calibration of the GC/MS is conducted as required to meet continuing calibration criteria using five concentrations. Response factors of four system performance check compounds (SPCCs) and 13 calibration check compounds (CCCs) are examined. The SPCC response factors should exceed 0.050. The relative standard deviation of the CCC response factors should be less than 30 percent.

A continuing calibration check is run every 12 hours. The SPCC response factors should meet the same criteria as in the initial calibration, and the CCC response factors may not deviate more than 25 percent from the average response factor of the initial calibration. Analysis may proceed if the SPCC and CCC criteria are met for 15 out of 17 compounds (90 percent).

The internal standard calibration method is used to quantitate samples. Internal standard area counts in any sample must fall between 50 and 200 percent of the internal standard area in the continuing calibration for that run.

7.2.3 Volatile Organics, Pesticides, Herbicides, and Fuels by GC

Initial calibration using five concentrations is performed every six months, or more frequently as required to meet continuing calibration criteria. The calibration curve is forced through zero, and it must have a correlation factor of 0.990 or greater. A continuing calibration standard is analyzed with each day's run. The difference between the average response factor of the initial standard curve and the response factor of the continuing calibration must fall within the limits established by the SOP. The internal standard calibration method is used to quantitate samples.

7.2.4 Metals by ICP

The instrument is calibrated at the beginning of each run using a blank and at least one standard concentration. If more than one standard is used, the correlation coefficient must be greater than 0.995. A second-source initial calibration verification (ICV) standard is analyzed following the calibration, and a continuing calibration verification (CCV) is analyzed after every ten samples. The measured concentration of these standards must be within 10 percent of the true concentration. A calibration blank is analyzed with every calibration verification standard. The absolute value of the measured concentration must be less than the detection limit.

7.2.5 Metals by Graphite Furnace, Flame, Cold Vapor, and Hydride Generation

Each day, prior to sample analysis, a calibration curve of a blank and at least three standards is run. The calibration curve must have a correlation coefficient of 0.995 or greater. A second-source ICV is analyzed after the calibration standards and a CCV is analyzed after every ten samples. The apparent concentration of these standards must lie within 10 percent of the true concentration.

7.2.6 Colorimetric and Spectrophotometric Analyses

A calibration curve of a blank and at least three standards is prepared daily or as required to meet continuing calibration criteria. The correlation coefficient of the curve must be 0.995 or greater. If the calibration curve is not prepared daily, a calibration verification standard is analyzed with each day's run. The measured concentration of this standard must be within 10 percent of the true concentration.

7.2.7 Titrimetric Analyses

Titrimetric analyses are standardized with primary standards every six months, or as required by the SOP. Three repeat titrations must agree to within 2 percent of each other.

7.2.8 Gravimetric Analyses

Balances are calibrated annually by a qualified service technician. The calibration is checked daily with class "S" weights as described in BCA SOP #MI00888. The weights are annually certified to be within class S tolerances. The recorded weight must lie within the acceptance limits listed in the SOP.

7.2.9 pH

The pH meter is calibrated with two buffers separated by three pH units prior to each day's analysis. The slope must meet the criteria set by the manufacturer. The measured pH of a third buffer must be within 0.1 unit of the true value.

7.2.10 Biochemical Oxygen Demand (BOD)

The dissolved oxygen meter is calibrated daily either by Winkler titration or a combination of Winkler and air calibration. The sodium thiosulfate titrant is standardized every three months using primary standard bi-iodate. Three repeat titrations must agree to within 2 percent of each other. The thermometer used to measure the incubator temperature is calibrated annually using an NIST-certified thermometer. The readings must agree to within 0.1°C, or a correction factor applied.

7.2.11 Ion Selective Electrodes

The meter is calibrated for each day's run using at least three standard concentrations. The semilogarithmic curve must have a correlation coefficient greater than 0.995.

7.2.12 Turbidity

The nephelometer is calibrated monthly using either primary standard formazin suspensions or EPA-approved commercial standards. The calibration is checked with each day's run using secondary standard Gelex suspensions. The reading must agree to within 5 percent of the original reading taken immediately after calibration.

7.2.13 Ion Chromatography

A calibration curve is generated as required to meet calibration verification criteria using a blank and at least three concentrations. The correlation coefficient must be greater than 0.995. The calibration is verified each day of operation and after every 20 samples by analyzing a calibration verification standard. The measured value must be within 10 percent of the true value.

7.2.14 Microbiology

The thermometers used to measure incubator temperatures are calibrated annually against an NIST-certified thermometer. The reading must agree to within 0.1°C, or a correction factor is applied.

7.2.15 Gross Alpha and Beta

The counting efficiency curve is prepared annually or as needed when instrument parameters are changed. Standards of constant alpha and beta activity level are prepared to cover a range of solids concentrations to measure self absorption due to solids. The correlation coefficient of the cubic regression must be greater than 0.67.

Section 8 Analytical Procedures

8.1 Sources

Analytical procedures used at B C Analytical are determined by current environmental regulations set forth by both the federal and state governments. The following manuals and references contain most of the mandated methods for these regulations. Codes in parentheses correspond to the sources listed in the tables in this section.

Test Methods for Evaluating Solid Waste, United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, November 1986, SW-846 Third Edition, Revision 0, Update 1, and Update 2. (EPA)

Methods for Chemical Analysis of Water and Wastes, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, EPA-600/4-79-020, Revised March 1983. (EPA)

Code of Federal Regulations 40, Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," *Part 141*, "National Primary Drinking Water Regulations," *Part 60*, "Standards of Performance for New Stationary Sources," *Part 61*, "National Emission Standards for Hazardous Air Pollutants," Office of the Federal Register National Archives and Records Administration, Revised July 1, 1991. (EPA)

Methods for the Determination of Organic Compounds in Drinking Water, United States Environmental Protection Agency, Environmental Monitoring Systems Laboratory, EPA-600/4-88/039, December 1988. (EPA)

Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 14th Edition, 1976 (SM14); 16th Edition, 1985 (SM16); 17th Edition, 1989 (SM17); 18th Edition, 1992 (SM18).

Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, United States Environmental Protection Agency, Office of Research and Development, EPA/600-4-90/027, September 1991. (EPA)

Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, State of California Leaking Underground Fuel Tank Task Force, October 1989. (LUFT)

California Code of Regulations, Title 22, Division 4 Environmental Health, and 4.5 Environmental Health Standards for the Management of Hazardous Waste, Current Revision. (CA22)

Statement of Work for Inorganic Analysis, Multi-Media, Multi-concentration, Document OLM01.0, USEPA Contract Laboratory Program, April 1990

Statement of Work for Organics Analysis, Multi-Media, Multi-concentration, Document OLM01.0, Including revisions through OLM01.6, June 1991

Test Methods for Emissions from Stationary Sources, California Air Resources Board, March 23, 1988. (CARB)

8.2 Selection of Analytical Procedures

The B C Analytical User's Guide and Fee Schedule describe the major regulations and accompanying laboratory services that BCA is capable of providing. Tables 8-1 through 8-4 itemize methods used for the most commonly requested regulations. Refer to Table 8-1 for analyses under the Safe Drinking Water Act, Table 8-2 for analyses under the Clean Water Act, Table 8-3 for analyses under the Resource Conservation and Recovery Act, and Table 8-4 for analyses under the Clean Air Act.

8.3 Standard Operating Procedures for Analytical Methods

In addition to the procedures from sources given in Section 8.1, BCA writes our own Standard Operating Procedures (SOPs) for analytical methods. These documents are reviewed at least every two years against the actual procedures currently being used and against EPA- and state-mandated procedures for correctness. SOPs are used as training guides and as a precise description of the procedure as performed at BCA. BCA SOP numbers are given for the analytical methods listed in Tables 8-1 through 8-4. The SOP system is described in SOP #MI00188, "Writing, Reviewing, and Issuing SOPs."

8.4 Response to Data Quality Objectives

The methods listed in Table 8-1 are used to achieve data quality objectives for most projects and regulatory requirements. When data quality objectives specify additional requirements, supplemental SOPs are developed to comply with project DQOs.

Table 8-1 METHODS FOR ANALYSIS OF DRINKING WATER

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Total Coliform	BA00389	SM16	908A	Multiple tube fermentation
		EPA		Minimal media ONPG-MUG
Fecal Coliform	BA00589	SM16	908C	Multiple tube fermentation
E. Coli		EPA		Minimal media ONPG-MUG
Heterotrophic Plate Count	BA00689	SM16	907A	Pour plate method
Alkalinity	GE01689	EPA	310.1	Titrimetric, pH 4.5
Chloride		EPA	325.3	Titrimetric, mercuric nitrate
Color		EPA	110.2	Colorimetric, Pt-Co
Corrosivity	MI02092	SM16	203	Langelier Saturation Index
Cyanide	GE00388	EPA	335.2	Spectrophotometric
Hardness	GE02189	EPA	130.2	Titrimetric, EDTA
Fluoride		EPA	340.2	Ion selective electrode
Foaming Agents (MBAS)	GE00888	EPA	425.1	Colorimetric, methylene blue
Nitrate		EPA	353.2	Colorimetric, automated cadmium reduction
	GE01289	EPA	300.0	Ion Chromatography
Nitrite		EPA	353.2	Colorimetric, automated cadmium reduction
		EPA	354.1	Spectrophotometric
Odor		EPA	140.1	Threshold odor
pH	GE01389	EPA	150.1	Electrometric
Phosphate, ortho	GE02089	EPA	365.2	Colorimetric, ascorbic acid
Silica	GE01089	EPA	370.1	Colorimetric
Specific Conductance	GE01589	EPA	120.1	Wheatstone bridge
Sulfate	GE01789	EPA	375.4	Turbidimetric
	GE01289	EPA	300.0	Ion Chromatography
Total Dissolved Solids	GE00188	EPA	160.1	Gravimetric, 180 C
Aluminum	ME00288	EPA	200.7	Inductively coupled plasma
Antimony	ME00288	EPA	200.7	Inductively coupled plasma
Arsenic	ME01588	EPA	206.2	Graphite furnace AA
Barium	ME00288	EPA	200.7	Inductively coupled plasma
Beryllium	ME00288	EPA	200.7	Inductively coupled plasma
Cadmium	ME01588	EPA	213.2	Graphite furnace AA
Calcium	ME00288	EPA	200.7	Inductively coupled plasma
Chromium	ME01588	EPA	218.2	Graphite furnace AA
Copper	ME01588	EPA	220.2	Graphite furnace AA
	ME00288	EPA	200.7	Inductively coupled plasma
Iron	ME00288	EPA	200.7	Inductively coupled plasma
Lead	ME01588	EPA	239.2	Graphite furnace AA
Magnesium	ME00288	EPA	200.7	Inductively coupled plasma
Manganese	ME00288	EPA	200.7	Inductively coupled plasma
Mercury	ME01689	EPA	245.1	Manual cold vapor AA
Nickel	ME00288	EPA	200.7	Inductively coupled plasma
Potassium	ME00288	EPA	200.7	Inductively coupled plasma
Selenium	ME01588	EPA	270.2	Graphite furnace AA
Silver	ME01588	EPA	272.2	Graphite furnace AA
	ME00288	EPA	200.7	Inductively coupled plasma
Sodium	ME00288	EPA	200.7	Inductively coupled plasma
Thallium	ME00288	EPA	200.7	Inductively coupled plasma
Zinc	ME00288	EPA	200.7	Inductively coupled plasma
VOCs	MS00792	EPA	524.2	Purge & trap GC/MS
EDB & DBCP		EPA	504	Gas Chromatography
Gross Alpha and Beta	ME01791	SM17	7110	Proportional Counter

Table 8-2 METHODS FOR ANALYSIS OF WASTEWATER

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Total Coliforms	BA00389	SM17	9221B	Multiple tube fermentation
Fecal Coliforms	BA00589	SM17	9221C	Multiple tube fermentation
Fecal Streptococci		SM17	9230B	Multiple tube technique
Bioassay	BA00891	EPA		Acute static, sol'n renewal, threespine stickleback, rainbow trout, fathead minnow
Acidity		EPA	305.1	Titrimetric
Alkalinity	GE01689	EPA	310.1	Titrimetric, pH 4.5
Ammonia	GE02691	EPA	350.3	Distillation/ion selective electrode
	GE01188	EPA	350.1	Distillation/colorimetric, automated phenate
Biochemical Oxygen Demand (BOD)	GE00688	EPA	405.1	Oxygen depletion, electrode
Boron	GE02389	EPA	212.3	Colorimetric, curcumin
	ME00288	EPA	200.7	Inductively Coupled Plasma
Bromide		EPA	320.1	Titrimetric
Carbonaceous BOD	GE00688	SM17	5210B	BOD, nitrification inhibitor
Chemical Oxygen Demand (COD)		EPA	410.4	Spectrophotometric, manual
Chloride		EPA	325.3	Titrimetric, mercuric nitrate
Chlorine Residual		EPA	330.2	Titrimetric, back- iodimetric
		EPA	330.5	Spectrophotometric, DPD
Color		EPA	110.2	Colorimetric, Pt-Co
Cyanide	GE00388	EPA	335.2	Spectrophotometric
Cyanide Amenable to Chlorination		EPA	335.1	Spectrophotometric
Fluoride		EPA	340.2	Ion selective electrode
Hardness	GE02189	EPA	130.2	Titrimetric, EDTA
Kjeldahl Nitrogen		EPA	351.3	Colorimetric; titrimetric; potentiometric
		EPA	351.2	Colorimetric, semiautomated block digester
Nitrate		EPA	353.2	Colorimetric, automated cadmium reduction
Nitrite		EPA	353.2	Colorimetric, automated cadmium reduction
Oil & Grease	GE01889	EPA	413.1	Gravimetric, extraction
Organic Carbon		EPA	415.1	Combustion or oxidation
Oxygen, Dissolved		EPA	360.1	Membrane electrode
pH	GE01389	EPA	150.1	Electrometric
Petroleum Hydrocarbons	GE01088	EPA	418.1	Spectrophotometric, IR
Phenols	GE00288	EPA	420.1	Spectrophotometric, manual 4-AAP w/distillation
Phosphate, Ortho	GE02089	EPA	365.2	Colorimetric, ascorbic acid, single reagent
Phosphorus, Total	GE02089	EPA	365.2	Colorimetric, ascorbic acid, single reagent
	GE02089	EPA	365.4	Colorimetric, automated, block digester
Solids, Total		EPA	160.3	Gravimetric, 103-105 C
Filterable	GE00188	EPA	160.1	Gravimetric, 180 C
Nonfilterable	GE00488	EPA	160.2	Gravimetric, 103-105 C
Settleable		EPA	160.5	Volumetric, Imhoff cone
Volatile		EPA	160.4	Gravimetric, 550 C
Silica	GE01989	EPA	370.1	Colorimetric
Specific Conductance	GE01589	EPA	120.1	Wheatstone bridge
Sulfate	GE01789	EPA	375.4	Turbidimetric
Sulfide	GE02791	EPA	376.2	Colorimetric, methylene blue
Sulfite		EPA	377.1	Titrimetric
Surfactants (MBAS)	GE00888	EPA	425.1	Colorimetric, methylene blue
Tannin and Lignin		SM17	5550	Colorimetric
Total Organic Halides	GE00588	SM17	5320	Microcoulometric titration
Turbidity	GE01489	EPA	180.1	Nephelometric
Aluminum	ME00288	EPA	200.7	Inductively coupled plasma
Antimony	ME00288	EPA	200.7	Inductively coupled plasma
	ME01588	EPA	204.2	Graphite furnace AA
Arsenic	ME01588	EPA	206.2	Graphite furnace AA
		EPA	206.3	Hydride generation - AA

Table 8-2 cont'd METHODS FOR ANALYSIS OF WASTEWATER

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Barium	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	208.1	Flame AA
	ME01588	EPA	208.2	Graphite furnace AA
Beryllium	ME00288	EPA	200.7	Inductively coupled plasma
	ME01588	EPA	210.2	Graphite furnace AA
Cadmium	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	213.1	Flame AA
	ME01588	EPA	213.2	Graphite furnace AA
Calcium	ME01088	EPA	200.7	Inductively coupled plasma
Chromium	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	218.1	Flame AA
	ME01588	EPA	218.2	Graphite furnace AA
Chromium (VI)	GE02289	SM17	311C	Colorimetric, diphenylcarbazide
Cobalt	ME00288	EPA	200.7	Inductively coupled plasma
	ME01588	EPA	219.2	Graphite furnace AA
Copper	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	220.1	Flame AA
	ME01588	EPA	220.2	Graphite furnace AA
Iron	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	236.1	Flame AA
Lead	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	239.1	Flame AA
	ME01588	EPA	239.2	Graphite furnace AA
Magnesium	ME01088	EPA	200.7	Inductively coupled plasma
Manganese	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	243.1	Flame AA
Mercury	ME01689	EPA	245.1	Manual cold vapor AA
Molybdenum	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	246.2	Graphite furnace AA
Nickel	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	249.1	Flame AA
	ME01588	EPA	249.2	Graphite furnace AA
Potassium	ME01088	EPA	200.7	Inductively coupled plasma
Selenium	ME01588	EPA	270.2	Graphite furnace AA
		EPA	270.3	Hydride generation - AA
Silver	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	272.1	Flame AA
	ME01588	EPA	272.2	Graphite furnace AA
Sodium	ME01088	EPA	200.7	Inductively coupled plasma
Thallium	ME00288	EPA	200.7	Inductively coupled plasma
	ME01588	EPA	279.2	Graphite furnace AA
Tin	ME00188	EPA	282.1	Flame AA
Titanium	ME00188	EPA	283.1	Flame AA
Vanadium	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	286.1	Flame AA
	ME01588	EPA	286.2	Graphite furnace AA
Zinc	ME00288	EPA	200.7	Inductively coupled plasma
	ME00188	EPA	289.1	Flame AA
Volatile Organic Compounds (VOCs)	MS00188	EPA	624	GC/MS
Base/Neutral and Acid Extractables	MS00288	EPA	625	GC/MS
Halogenated VOCs	GC00188	EPA	601	GC/HECD
Aromatic VOCs	GC00188	EPA	602	GC/PID
Phenols		EPA	604	GC/FID (MS confirmation)
Organochlorine Pesticides and PCBs	GC00588	EPA	608	GC/dual ECD
Alpha, Total	ME01791	SM17	7110	Proportional counter
Beta, Total	ME01791	SM17	7110	Proportional counter

Table 8-3 METHODS FOR ANALYSIS OF HAZARDOUS WASTE

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Bioassay	BA00188		CA22	Screen, LC50, Fathead Minnow
Chromium VI	GE02289	EPA	7196	Colorimetric
Corrosivity		EPA	1110	NACE corrosion to steel
Cyanide	GE00388	EPA	9010	Spectrophotometric
Ignitability		EPA	1010	Pensky-Martens closed cup
pH	GE01389	EPA	9040	Electrometric
Reactivity		EPA	7.3	Water & acid reactivity, cyanide & sulfide generation
Soil pH	GE01389	EPA	9045	Slurry pH
Sulfide		EPA	9030	Gas generation, titrimetric
Total Organic Halides	GE00588	EPA	9020	Microcoulometric titration
Antimony	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7040	Flame AA
	ME01588	EPA	7041	Graphite furnace AA
Arsenic	ME00288	EPA	6010	Inductively coupled plasma
	ME01588	EPA	7060	Graphite furnace AA
		EPA	7061	Hydride generation - AA
Barium	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7080	Flame AA
	ME01588	EPA	7081	Graphite furnace AA
Beryllium	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7090	Flame AA
	ME01588	EPA	7091	Graphite furnace AA
Cadmium	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7130	Flame AA
	ME01588	EPA	7131	Graphite furnace AA
Cromium, Total	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7190	Flame AA
	ME01588	EPA	7191	Graphite furnace AA
Cobalt	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7200	Flame AA
	ME01588	EPA	7201	Graphite furnace AA
Copper	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7210	Flame AA
	ME01588	EPA	7211	Graphite furnace AA
Lead	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7420	Flame AA
	ME01588	EPA	7421	Graphite furnace AA
Mercury	ME01689	EPA	7470	Cold vapor AA (aqueous)
	ME01689	EPA	7471	Cold vapor AA (solids)
Molybdenum	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7480	Flame AA
	ME01588	EPA	7481	Graphite furnace AA
Nickel	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7520	Flame AA
Organic Lead	ME01891		LUFT	Solvent extraction, AA
Selenium	ME00288	EPA	6010	Inductively coupled plasma
	ME01588	EPA	7740	Graphite furnace AA
		EPA	7741	Hydride generation AA
Silver	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7760	Flame AA
	ME01588	EPA	7761	Graphite furnace AA

Table 8-3 cont'd METHODS FOR ANALYSIS OF HAZARDOUS WASTE

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Thallium	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7840	Flame AA
	ME01588	EPA	7841	Graphite furnace AA
Vanadium	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7910	Flame AA
	ME01588	EPA	7911	Graphite furnace AA
Zinc	ME00288	EPA	6010	Inductively coupled plasma
	ME00188	EPA	7950	Flame AA
EP TOX Extraction	PR01889	EPA	1310	24-hr, PH = 5.0, 1:20 solid to leachate
TCLP Extraction	PR02789	EPA	1311	18-hr, PH = 4.93 or 2.88, 1:20 solid to leachate
WET Extraction	PR01389	CA22		48-hr, PH = 5.0, 1:10 solid to leachate
Volatile Organics	MS00188	EPA	8240	GC/MS
		EPA	8260	GC/MS, capillary column
Semivolatile Organics	MS00288	EPA	8270	GC/MS
Halogenated Volatiles	GC00188	EPA	8010	GC/HECD
EDB and DBCP		EPA	8011	GC/ECD
Aromatic Volatiles	GC00188	EPA	8020	GC/PID
Halogenated and Aromatic Volatiles	GC00188	EPA	8021	GC/HECD/PID
Phenols		EPA	8040	GC/FID
Organochlorine Pesticides and PCBs	GC00588	EPA	8080	GC/ECD
Organo phosphorus Pesticides	GC00988	EPA	8140	GC/NPD/FPD
		EPA	8141	GC/NPD/FPD, capillary column
Chlorinated Herbicides	GC01489	EPA	8150	GC/ECD
Petroleum Hydrocarbons	GE01088	EPA	418.1	Spectrophotometric, IR
	GC01190	EPA	8015M	Purge & trap - GC/FID
	GC00288	EPA	8015M	Extraction - GC/FID
	GC01289	EPA	8015M	Extraction, concentration - GC/FID
Gross Alpha and Beta	ME01791	EPA	9310	Proportional counter

Table 8-4 METHODS FOR ANALYSIS OF AIR

ANALYTE	SOP	SOURCE	METHOD	DESCRIPTION
Particulates		CARB	5	Gravimetric
Sulfuric Acid		CARB	8	Ion chromatography
Hydrochloric Acid		CARB	421	Ion chromatography
Fluoride		CARB	13B	Ion chromatography
Arsenic		CARB	423	Microwave digest, AA
Beryllium		CARB	104	Microwave digest, AA or ICP
Cadmium		CARB	424	Microwave digest, AA or ICP
Chromium				
III and VI		CARB	425	Ion chromatography, AA
Lead		CARB	12	Microwave digest, AA or ICP
Mercury		CARB	101A	Microwave digest, cold vapor
Nickel		CARB	433	Microwave digest, AA or ICP
Benzene	MS00490	CARB	410	GC/MS
Halogenated Organics	MS00490	CARB	422	GC/MS
Vinyl Chloride	MS00490	CARB	106	GC/MS
Acetaldehyde		CARB	430	HPLC
Formaldehyde		CARB	430	HPLC

Section 9 Data Reduction, Validation, and Reporting

At B C Analytical, we communicate test results to clients through the analytical report, usually delivered by mail. This document is based on the client's laboratory order, or group of related samples. Accompanied by project-specific supporting documentation, the analytical report represents the product of laboratory work. To arrive at this end point, lab staff use the processes of data reduction, validation, and reporting.

9.1 Data Reduction

Data reduction is the process by which the analyst translates raw data into a reported result that is reviewed by a second party before release to the final report. BCA's standard practices for reporting numerical results are described in SOP #QA00489 "Reporting Numerical Results - Significant Figures."

9.1.1 Manual reduction methods

Analysts often apply manual techniques to calculate usable results from the raw data. Manual reduction techniques are typically applied to methods that use instruments without computer interface or that do not use instrumentation.

9.1.1.1 Methods with non-PC based instrumentation

Some instruments are configured to operate without computers. For these, the signal is recorded as a strip-chart trace, as numerical output on a printer strip, or as direct reading from a digital or analog dial. In such cases, the analyst must then reduce the data to a reportable format, multiplying the original signal by a calibration factor or comparing it with a standard curve. All data are recorded in a bound notebook for the particular determination. See the SOP for the analysis of each type of test for further details.

9.1.1.2 Methods without instrumentation

Other tests, such as titrations or sensory evaluations, do not use instruments. For these, the analyst records the quantitative result or observation directly in a bound notebook. See the SOP for each type of test for further details.

9.1.2 Automated data reduction

Most data produced in the laboratory are generated through the use of dedicated instrumentation with microcomputer interfaces. These systems receive the original signal from the instrument to which the sample or extract was submitted. The PC or dedicated

minicomputer transforms the raw signal into a quantitative value. The analyst reviews this "candidate" result either on screen or on a printout, verifying identifications, double checking quantitative formulas, and acquiring final numerical values. The analyst writes out calculated results or checks off computer-produced results directly on the computer printout. The printout is cross-referenced to a file number in a bound run log.

9.1.2.1 Software validation

To assure the quality of the software used to generate data, BCA first tests the programs to make sure reliable results can be obtained.

9.1.2.2 Entry of data into the LIMS

The results are transcribed manually onto computer-generated worksheets and then entered by keyboard directly into the LIMS, or transmitted electronically through datalink. The datalink process bypasses the manual transcription of data. The data produced from PC-based systems or the minicomputer are captured in a program, reviewed on screen and edited by the analyst, and sent directly to the LIMS via serial port cable.

9.2 Data Validation

In today's commercial laboratory business, data validation is viewed as a function performed not necessarily by laboratory staff, but by the client's project manager, who compares the analytical data with the DQOs outlined in the project-specific Quality Assurance Project Plan (QAPP). It is therefore difficult, if not impossible, to set forth a policy for laboratory data validation without considering the specifics of each project. The amount of QC and restrictiveness of the control limits may vary depending on the intended use of the data. When the commercial laboratory accepts a project, these objectives must be clearly communicated or the data may not be usable. However, not all work is performed under QAPPs. Decisions must be made by the analyst, second party reviewer, and report reviewer to determine if the processes were in control. This is done in three steps: 1) bench data assessment, 2) second party review and approval, 3) final report review.

9.2.1 Bench data assessment for validity

To determine whether a process was in control, the analyst must review all data by checking the quality control parameters. There are two basic levels of assessment: the first is to assess each single QC parameter; the second, to assess the relationships among QC parameters.

The first level of assessment is to check each parameter against its limits to determine if it was in control or out of control. Each analysis has defined control limits for such individual QC parameters as initial calibration, calibration verification, LCS, matrix spike duplicates (MSD), and blanks. When these parameters contain multiple analytes, evaluation of the data set typically leads to a mixture of in-control and out-of-control points. To determine the overall control of the QC parameter, Level I completeness criteria are applied in the following manner:

1. Only a small percentage of analytes may be outside control limits to evaluate the QC parameter as complete. When statistical limits are used, the maximum allowable number of out-of-control analytes with respect to total number of analytes is given by the following table: (See Section 4.2.4.)

Total # Analytes	Allowable Out-of-Control Analytes
1-4	0
5-24	1
25-59	2
60-99	3
100+	4

When statistical limits are wider than those specified in the EPA method, the more restrictive limits are imposed, and the above criteria do not apply. In such cases, Level I completeness criteria are established for the individual method.

- When the same analyte is outside limits on consecutive days, it indicates that the outlier is systematic and not random. This aspect of the evaluation is called data trending. If the same analyte is outside limits for three consecutive batches or runs, the QC parameter is evaluated as out-of-control.
- The environmental significance of an individual analyte may be critical to meeting the DQOs of a project. In such cases where an environmentally significant analyte is outside limits, the QC parameter is evaluated as out-of-control.

The second level of assessment is applied to the relationships between the LCS percent recovery, the matrix spike recoveries, and the duplicate relative percent difference in a given batch. These relationships give rise to various combinations of in-control and out-of-control QC parameters. Level II completeness evaluation is used to determine whether the batch is in control. The following chart describes the eight possible relationships along with the corresponding batch evaluation. (Where "+" indicates an in-control parameter and "-" indicates an out-of-control parameter; if either of the duplicate spikes is out, that column gets a "-".)

	LCS	RPD	Spike	Batch Evaluation
Case 1	+	+	+	In-control
Case 2	-	-	-	Out-of-control
Case 3	+	+	-	In-control
Case 4	+	-	+	Out-of-control unless documented isolated failure
Case 5	-	+	+	Out-of-control unless documented isolated failure
Case 6	+	-	-	Out-of-control unless documented isolated failure
Case 7	-	+	-	Out-of-control
Case 8	-	-	+	Out-of-control

The basic requirement for an in-control analytical process is that it demonstrate acceptable accuracy and long-term precision in an interferent-free matrix (LCS) and acceptable precision in the sample matrix. In Case 3, the method as applied to a particular sample matrix yields inaccurate results. The matrix effects are confirmed by agreement

between the duplicate spikes, so the batch is in control. Also, when the spikes are invalidated due to high sample concentration, the LCS gives the only usable accuracy data.

In certain situations, analytical processes may be evaluated as in control even if these conditions are not met, because observation and judgment determine that an out-of-control QC parameter is not representative of the analytical batch. An isolated action, event, or situation affected the QC parameter, but did not affect the rest of the samples in the batch in the same manner. For example:

Case 4. The accuracy control limits for a difficult analyte or matrix type are relatively wide as compared to the precision control limits. There is the potential for both spike recoveries to be within limits but the RPD to fail.

Case 5. The internal standard response for the LCS was low, resulting in several compounds being evaluated as out of control. This internal standard response was not consistent with other samples in the batch.

Case 6. Inhomogeneity in the sample matrix was observed. A representative subsample could not be taken.

Method blank data are evaluated separately from the other batch QC parameters. When method blank contamination is observed, its influence on data validity depends on how significant the contamination is with respect to the samples analyzed in the batch. Samples with analyte concentration less than the detection limit and greater than ten times the contamination level are not affected. Others are considered invalid.

Evaluation criteria for instrument calibration are discussed in Section 7. Criteria for other QC parameters such as sample-specific and method-specific QC, are included in the Standard Operating Procedures for those tests.

When observing an out-of-control process, the analyst must initiate corrective action to bring the process in control and re-analyze samples if necessary. Corrective action requirements are discussed in Section 14.

9.2.2 Second Party Review for Approval

Once the data are entered into the LIMS (See SOP #CL00689, "Results Entry"), a second party reviews the data. This reviewer is typically the department supervisor or a trained analyst who did not generate the data. Work approval sheets (WAPs) may be printed any time after the data are entered—usually each night after data entry. At the same time, an "Early Warning Report," which compares the entered data to control limits contained in the matrix QC limits files, is printed. This report assists the second party reviewer in evaluating and approving the data.

The reviewer checks the data for typos and double checks QC parameters in the same manner as given in Section 9.2.1. The reviewer may decide that data are not reportable and thus initiate corrective action and re-analysis. The reviewer will also check that all necessary documentation has been completed. Guidance for second party review is given in SOP #QA01189, "Data Validation at Work Approval," and SOP #QA00989, "Early Warning Report."

Once data are approved, the second party reviewer initials the work approval sheets. Once initialed, the first draft of the completed report is printed. (See SOP #CL00589, "Data Entry of Work Approvals and Autoprint of Reports.")

9.2.3 Report Review and Final Release

Client services and project management staff fully review the completed draft report, viewing it both inter-departmentally and historically. They check the relationships between different analyses, such as COD greater than BOD, or total values greater than soluble values. If available, historical project data are checked to assess consistency. The client services representative or project manager may request corrective action and re-analysis if results do not compare and no explanation is given. Further guidance is given in SOP #QA01089, "Report Review."

After it's been reviewed, the draft report is photocopied onto letterhead (SOP #CL00892, "Producing the Final Report"). A designated signatory person, on file with the California Environmental Laboratory Accreditation Program, performs the final review. That person holds the legal responsibilities for reporting the laboratory results.

9.3 Reporting

9.3.1 The Basic Analytical Report (BCA Level I Report)

Components:

BCA log number
Date received at B C Analytical
Date mailed by B C Analytical
Report attention
Name and address of the client
Laboratory sample number(s)
Matrix of the sample(s)
Client sample description
Date sampled
Parameters and methods
Units
Results
Signature

9.3.2 Batch Supplement Report

Components:

BCA sample number
Client sample description
BCA determination code
Date analyzed
EPA method number
BCA equipment number
BCA batch number
Analyst ID number

9.3.3 Batch QC Report (BCA Level II Report)

Components:

BCA order number
Date printed

Laboratory Control Standards Data

- Parameter
- Date analyzed
- Batch number
- LC result (measured value)
- LT result (true value)
- Units
- Percent recovery

Matrix QC Precision Data (duplicates or duplicate spikes)

- Parameter
- Date analyzed
- Batch number
- S1 or R1 result (first spike or replicate)
- S2 or R2 result (second spike or replicate)
- Units
- Relative percent difference

Matrix QC Accuracy Data (spikes)

- Parameter
- Date analyzed
- Batch number
- Average spike result
- Expected (true) result
- Unspiked sample result
- Units
- Percent recovery

Method Blanks and Reporting Detection Limit

- Parameter
- Date analyzed
- Batch number
- Method blank result
- Reporting Detection Limit (undiluted sample)
- Units
- EPA method number

Definitions and Terms

9.3.3 BCA Level III Report

Components:

- Level I Analytical Report
- Batch Supplemental Report
- Batch QC Report
- Raw data

Full case narrative with appropriate forms and supporting documentation as described by the QAPP. See BCA SOP #QA00189, "Producing Level III Data Packages."

Specific guidance may be found in the following document: "Laboratory Documentation Requirements for Data Validation," Document Control Number 9QA-07-90, USEPA Region IX, January 1990. These reports conform to the voluntary standards of the Association of California Testing Laboratories (ACTLabs), "Industry-Wide Standard Practices - QC Level A," November 1992.

9.3.4 Customized Reports

Clients may require more information or information presented in a different format than our basic analytical report and Batch QC report can provide. Client services representatives, project managers, and BCA computer programmers are prepared to provide such customized reports.

9.4 Electronic Data Transfer

Data may be transferred electronically by downloading data onto a floppy disc or sending directly via computer modem. Clients requiring electronic data transfer work directly with BCA programmers, client services representatives, and BCA project managers so that programs are written to suit needs. All data to be sent electronically are reviewed against the hard copy report to make sure results are complete and identical.

9.5 Records Custody and Retention

All copies of final reports, notebooks, and raw data are retained for ten years. Typically, records are kept at the laboratory facility 6 to 12 months, then transferred to a secure off-site records storage facility. After ten years, data records are destroyed. These procedures are more fully discussed in SOP #QA00289, "Data Storage and Retrieval."

Section 10 Internal Quality Control Checks

10.1 Batch QC

A batch is defined as a group of 20 samples or less, of similar matrix type, processed together under the same conditions and with the same reagents. If the method includes a sample preparation step, samples are batched together during that step. Batch QC, the set of quality control checks associated with a batch of samples, is used to assess the validity of each batch as described in sections 9.2 and 13.1 of this manual. The set is also referred to as prep QC and method QC because the checks are carried through the entire method, including sample extraction. Control limits can be found in the Control Limits section of the BCA Quality Program Handbook. Each batch must include the following QC checks.

10.1.1 Method Blank

A method blank is a sample that contains no analyte. For water analysis, organic-free or deionized water is used. For solids analysis, no matrix is used, only analyte-free solvent. The method blank serves to measure contamination, if any, associated with the laboratory.

Calculations of method blank concentration are the same as those for samples. For analyses on solids, a standard aliquot of solid sample is assumed for calculation purposes so that the result can be compared directly to sample results and detection limits.

10.1.2 Laboratory Control Standard (LCS)

The LCS, sometimes referred to as QCCS (quality control check standard), is a blank that is spiked with a known amount of analyte. LCS recovery tests the accuracy of the method in the absence of matrix interferences. The spiking level is in the optimum range of the calibration curve, greater than 5 times the detection limit but less than the highest standard. Standard materials used for the LCS are from a source that is independent from that used for calibration standards so the LCS can be used to check the validity of the calibration curve. Where available, NIST or EPA traceable reference standards are used.

The LCS recovery is calculated as follows:

$$P = (LC/LT) \times 100$$

where

P = LCS percent recovery

LC = measured LCS concentration

LT = theoretical LCS concentration = $C \times (A/B)$

C = concentration of standard used to spike LCS

A = amount of spike added to LCS

B = total amount of LCS used

For solids analyses, the total amount of LCS used in the equation is assumed to be the standard aliquot of solid sample so the calculated concentration can be readily compared to sample concentrations.

10.1.3 Matrix Spike

The matrix spike is a sample spiked with a known amount of analyte. Spike recovery measures the effects of interferences in the sample matrix and reflects the accuracy of the determination. The spike level should be at least half, but not more than ten times, the analyte concentration in the sample. Because the spike is often prepared before the sample is analyzed, it is not always possible to spike in this range. If the sample concentration turns out to be greater than twice the spike concentration, the spike is considered invalid for measuring recovery.

Spike recovery is calculated as follows:

$$P = 100 \times (S-R)/(T-R)$$

where

P = percent spike recovery

S = measured concentration of spiked sample

R = measured concentration of unspiked sample

T = theoretical concentration of spiked sample = X+R

X = theoretical concentration of spike = C x (A/B)

C = concentration of standard used to spike sample

A = amount of spike added to sample

B = total amount of sample used

10.1.4 Duplicates and Duplicate Spikes

A duplicate is an additional aliquot of a sample, analyzed only for tests where matrix spikes are not feasible. A duplicate spike (also called matrix spike duplicate, or MSD) is an additional spiked aliquot of sample, analyzed for most tests. The relative percent difference (RPD) between duplicates or duplicate spikes measures precision—or reproducibility—of the determination in the actual sample matrix. If the sample's analyte concentration is less than five times the detection limit, duplicates are considered invalid for measuring RPD.

The RPD is calculated as follows:

$$RPD = \frac{|R1-R2|}{R_{av}} \times 100 \quad \text{[or]} \quad \frac{|S1-S2|}{S_{av}} \times 100$$

where

R1 & R2 = measured concentration in duplicate samples

S1 & S2 = measured concentration in duplicate spikes

R_{av} = average concentration in duplicate samples

S_{av} = average concentration in duplicate spikes

10.2 Run QC

An analytical run is defined as a series of analytical measurements performed on one instrument in a given time period. Quality control checks associated with an analytical run are called run QC—or instrument QC—because they check the functioning of the instrument at the time samples are being analyzed. The distinction is made because batch QC,

which is preparation-based, may not necessarily be analyzed in the same run with all the associated samples. However, results are not reported for a batch until all associated QC has been analyzed and evaluated. Acceptance criteria for run QC can be found in Section 7.2 and in the SOPs referenced in Section 8. Following are the most common run QC checks:

10.2.1 Calibration Blank

A calibration blank is identical in composition to a calibration standard, except that no analyte is added. It is used either as the zero-point on the calibration curve or to verify instrument response at zero concentration.

10.2.2 Initial Calibration

The initial calibration is performed by analyzing standards containing known levels of analyte concentration. The lowest calibration standard should be less than or equal to 10 times the detection limit, and the remaining standards should represent the entire range of quantitation levels.

10.2.3 Calibration Verification

When the calibration curve is not prepared for each run, it must be verified by analyzing a standard with analyte concentration in the mid-range of the curve.

10.2.4 Tuning Check

The tuning of the mass spectrometer is checked at the beginning of each GC/MS run to ensure that it is providing adequate spectra.

10.2.5 Interference Check Standard

Spectral interference is checked for each ICP run to ensure that inter-element and background correction is adequate.

10.3 Sample-Specific QC

Some quality control checks are specific only to one sample and are not used to make decisions regarding other samples. These include the following:

10.3.1 Internal Standard

An internal standard is a non-target analyte, which is added to samples and QC checks after preparation when the internal standard method is used for quantitation. It is used to compensate for variations from one sample to the next, such as detector response, aliquot measurement, and purge-and-trap efficiency.

10.3.2 Surrogate

A surrogate is a non-target analyte added to samples and batch QC checks for GC and GC/MS methods prior to preparation. It is used to check extraction efficiency and instrument response for each sample.

10.3.3 Confirmation

Analytes that are detected by GC analysis are confirmed by analysis on a second column with different retention properties, or by an alternate method such as GC/MS.

10.4 Microbiology QC

Each batch of purchased or sterilized sample containers is checked for sterility. Incubator temperatures are checked daily. Positive and negative control cultures are tested with each batch of prepared or purchased media for total coliforms, and each run for fecal coliforms. A completed test is performed on 10 percent of positives or once every quarter, whichever is more frequent.

10.5 Bioassay QC

Temperature, pH, and dissolved oxygen are measured and recorded daily for each tank. One tank of control fish accompanies each analytical batch. Known toxicants are analyzed periodically to verify test sensitivity.

10.6 Other

The following general quality control checks are necessary to assure high-quality analytical data:

10.6.1 Laboratory Pure Water Checks

Water purification systems are maintained to produce ASTM type I and type II water quality as well as organic-free water. Each system is monitored routinely for conductance or resistance to assure that quality standards are met. Other parameters are monitored by analysis of blanks as described above. Residual chlorine is checked with each use for microbiology, and bacteriological suitability is checked annually.

10.6.2 Refrigerators

Sample storage refrigerator temperatures are monitored daily and documented to ensure that cold sample storage is maintained at $4 \pm 2^{\circ}\text{C}$. This procedure is documented in BCA SOP #SA00789. The thermometers are checked annually against a NIST-certified thermometer.

10.6.3 Drying Ovens

Drying oven temperatures for gravimetric analyses are monitored routinely and documented to ensure that they are maintained at recommended temperatures.

10.6.4 Balances

All laboratory balances are checked daily as described in BCA SOP #MI00888, and Section 7.2.8 of this manual.

10.6.5 Fume Hoods

Air flow through the fume hoods is checked quarterly using an air flow velocity meter to ensure that adequate air flow is maintained, thus avoiding harmful exposure and cross contamination.

10.6.6 Eppendorf Pipettors

Mechanical pipettors that are used in place of class A glassware for volumetric dilutions of samples and standards are checked quarterly by weighing the volume of laboratory pure water delivered on an analytical balance as described in BCA SOP #MI00388.

Section 11 Performance and System Audits

Regulators, major clients, and the laboratory itself carry out quality audits. Audit programs may include unknown check standards (performance evaluation, or PE, samples), detailed review of quality assurance/quality control documentation, and on-site auditing. The on-site audits may be highly detailed with a program-specific checklist or simply a general verification of basic capability.

External audits—those carried out by others—are intended to grant official approval for a particular kind of analytical work. Some result in the approval by a government agency to allow commercial third-party work and reporting in a particular jurisdiction or analytical discipline. Others are a condition of a specific client relationship, not extending to third parties. The laboratory's internal audits verify compliance with BCA's principles and practices of quality assurance and quality control.

11.1 External Audits

11.1.1 California Department of Health Services, Environmental Laboratory Approval Program (ELAP)

All three BCA labs are ELAP-approved in a variety of analytical categories. The program relies on USEPA PE samples, and the department personnel conduct on-site audits every second year. In the category of drinking water analysis, the ELAP represents California primacy for lab certification as granted by EPA. For wastewater and hazardous waste analysis, there is no national certification program; ELAP approval is for California regulatory purposes only.

The ELAP certificate covers 23 "fields of testing" organized by sample matrix type and testing discipline. Each field is further subdivided into specific analytes or techniques. BCA labs are approved for components in most of the fields. The QA coordinators and client services representatives can provide copies of ELAP certificates.

11.1.2 Other States

BCA holds certifications in Arizona, Nevada, and Tennessee.

11.1.3 Other Government Programs

Mitre Corporation conducts audits of the Emeryville and Glendale labs every second year as part of the U.S. Air Force's laboratory approval program. One of the most rigorous of public agency programs, the Air Force audits are conducted by two experienced examiners over a period of three days. While the program does not use additional PE samples, the auditors examine records of other PEs run by the lab. The audit looks for specific compliance with Air Force quality requirements.

The Glendale laboratory is also approved for U. S. Navy analytical work. The approval program, now also operated directly by Mitre Corporation, was previously administered by Martin Marietta Corporation. Separate PE samples are provided, on-site audits are conducted, and special Navy documentation requirements are examined.

11.1.4 Commercial client audits

BCA participates in laboratory-approval programs operated by Chemical Waste Management, Shell Oil Company, Anheuser Busch, Chevron, 3M, New United Motor, and Hargis and Associates, among others. The programs include combinations of PE samples, on-site audits, and documentation requirements.

11.2 Internal Audits

11.2.1 Quarterly Quality Audit

Using a detailed audit checklist (updated at periodic intervals), the QA director conducts a quarterly examination in all three laboratories. The checklist contains over 300 questions, drawn from comments expressed throughout the range of external audits discussed above. Each laboratory's score is tabulated and posted as part of a total quality rating matrix, which is updated monthly.

11.2.2 Batch Completeness

Every month, each lab runs a computer program in LIMS that examines batch records for the presence of a complete complement of QC data. Batches are considered "complete" when they have all of the QC components defined in this manual and in specific SOPs. The number of batches complete, times 100, is divided by the number of total batches for a percent completeness score. This figure also becomes part of each lab's total quality matrix rating.

11.2.3 Amended Work

The division accountant receives, records, and tabulates any invoices returned for correction. The QA director reviews all report footnotes each month and tabulates those that have been revised or amended based on some laboratory mistake. These "amended work products" are added together and divided by the total number of reports and invoices issued during the month. The figure, multiplied by 1000 to report on a parts-per-thousand basis, is the lab's amended work product score for the month.

11.2.4 External Check Standards

Many of the audit programs described above include the use of PE samples. Delivered irregularly and scored independently, they do not lend themselves to a summary view of laboratory performance on unknowns. Therefore, we summarize the most recent six months of PE sample reports. The ones judged "in range" by the PE supplier are divided by the total number, multiplied by 100, and scored as percent in range. Repeated monthly, the score contributes a six-month moving average value to the total quality matrix.

11.2.5 Corrective Action

This audit, conducted monthly by the QA coordinator and the laboratory manager, measures compliance with BCA's corrective action policies and procedures. Working from accumulated daily Early Warning Reports, the auditors select at least 20 examples of QC outliers that would have been subject to corrective action. They then go directly to the

analytical departments and verify compliance with SOP #QA00789, "Corrective Action." Incidents that were appropriately handled and correctly documented are considered compliant; others are not. The count of correctly handled instances is divided by the total number examined to provide the corrective action score.

11.2.6 Housekeeping/Safety

BCA has a comprehensive Chemical Hygiene Plan to help provide a safe and healthful working environment for all employees. We also believe that a neat, orderly work place contributes to precise, accurate results. To support both goals, a site audit is conducted monthly by each lab manager or director for compliance with housekeeping and safety standards. Areas are individually rated and the results combined to provide a lab-wide score.

11.2.7 Turnaround Time

Second only to technical accuracy of results, the timeliness of reporting is critical to meeting client expectations. To audit ourselves in that area, BCA runs a LIMS summary of turnaround time every month. Weighted equally between dollar value and total number of sample orders (to address both large and small clients) the index tracks the percent of jobs (laboratory orders) completed when promised. Because any missing data point prevents an entire report from being considered complete, scoring on a whole-report basis holds the laboratory to a more rigorous standard than just measuring percent of analytical work completed by the due date.

Like the quarterly quality audit, this component of the total quality matrix requires teamwork across the entire organization. For reports to be delivered on time, each step in the sequence must go smoothly, with processes in control. The client requirements must be accurately understood by the client services representative, log-in must be complete and accurate, analysis must proceed at the earliest opportunity (with full quality control support), expert report review must be provided, and a final inspection and signing must take place. Throughout the sequence, support services such as clerical, quality assurance, information services, and lab management must provide resources and attention to every client project.

Section 12 Preventive Maintenance

12.1 Facilities

Facilities maintenance falls under the responsibility of the laboratory manager. Major systems such as air conditioning, heating, fume hoods, telephones, security, and safety equipment are maintained under service contracts. Table 12-1 lists examples of routine preventive maintenance tasks for many of these systems.

Table 12-1 PREVENTIVE MAINTENANCE

EQUIPMENT/SPARE PARTS	MAINTENANCE	FREQUENCY
Fume hood	Check belts for wear	Monthly
fans	Clean fan blades and impellers	Monthly
fan belts	Adjust belt tension	As needed
	Check air flow rate in hood	Quarterly
Air conditioning/ heating system	Check refrigerant charge	Monthly
filters	Check for worn parts	Monthly
fan belts	Clean coil surfaces	Monthly
	Replace filters	As needed
Air compressor	Drain condensate - manual	Daily
filters	Check oil level	Monthly
	Clean or replace filter	As needed
	Lube motor bearings	As needed
Deionized water system	Check resistivity	Daily
spare tanks	Change tanks	As needed
Ultrapure water system	Check resistivity	Daily
filters, cartridges	Change filters, cartridges	As needed
Computer system	File save	Daily
	Remove obsolete files	Monthly
	Clear out security log	Monthly
	Compact disk files	Monthly
	System backup	Quarterly
	Remove old data from disk	Yearly

Table 12-1 Cont'd PREVENTIVE MAINTENANCE

EQUIPMENT/SPARE PARTS	MAINTENANCE	FREQUENCY
Printers		
ribbons	Change ribbon	Weekly
paper	Check paper level	Daily
Gas chromatograph	Check carrier gas pressure	Daily
septa	Change septa	Weekly
liners	Change liner	As needed
columns	Clip column	As needed
ferrules	Change guard column	As needed
syringes	Change syringe	As needed
Mass spectrometer	Check oil level on pumps	Daily
source	Check vacuum gauge	Daily
source parts	Check source/analyzer pressure	Daily
	Clean source	As needed
Purge and trap	Check for leaks	Daily
traps	Replace trap	As needed
ELCD detector	Check solvent level	Daily
reaction tube	Change reaction tube	As needed
transfer line	Clean cell	As needed
	Clean or replace transfer line	As needed
	Replace roughing resin	As needed
PID detector	Check sensitivity	Daily
lamps	Clean or change lamp	As needed
FID detector	Check sensitivity	Daily
flame tips		
detector probe		
ignitor probe		
NPD detector		
collector beads	Replace collector bead	As needed
ICP-AES	Check argon	Daily
torch		Check torch
assembly	Daily	
nebulizers	Check cooling water	Daily
pump tubes	Check pump tubing for wear	Daily
	Check vacuum pump oil level	Daily
	Check drain	Daily
	Check windows	Daily
	Clean torch	As needed
	Replace pump tubing	As needed

Table 12-1 Cont'd PREVENTIVE MAINTENANCE

EQUIPMENT/SPARE PARTS	MAINTENANCE	FREQUENCY
Graphite furnace	Check argon and alternate gas	Daily
tubes	Check graphite tube	Daily
platforms	Check windows	Daily
lamps	Check water/drain and trap	Daily
contact rings	Check contact rings	Daily
Flame AA	Check acetylene and air	Daily
lamps	Check burner head	Daily
cells	Check nebulizer	Daily
Check drain	Daily	
Rapid flow analyzer	Check pump tubing for wear	Daily
pump tubes	Replace pump tubing	As needed
lamps	Replace lamp	As needed
TOX analyzer	Check furnace temperature	Daily
inlet tubes	Rinse cell	Daily
outlet tubes	Check gas pressures	Daily
cell	Clean inlet and exit tubes	Daily
pyrolysis tube	Recondition electrodes	As needed
	Clean pyrolysis tube	As needed
Ion chromatograph	Check gas pressure	Daily
columns	Check for leaks	Daily
seals	Perform column cleanup	As needed
frits	Perform suppressor cleanup	As needed
pH meter	Check electrolyte level	Daily
probe	Remove junction deposits	As needed

12.2 Equipment

Instrumentation is continually upgraded in order to provide state-of-the-art technology. Instruments used to generate data are numbered and logged into a computer database, so that a current equipment list can be easily generated at any time. The instrument number is archived with each sample result the instrument generates.

Instruments are constantly monitored through the use of daily calibration, sensitivity, and background checks to determine when nonscheduled maintenance is required (see Sections 7 and 10.2). Preventive maintenance is applied regularly to reduce the occurrence of instrument failure. In the event that an instrument does fail, every effort is made to meet obligations to clients concerning holding times and analysis due dates. All our laboratories have the option to send work to another BCA lab (with client consent) to avoid data loss due to instrument down time.

Major instruments (e.g. gas chromatographs, atomic absorption spectrophotometers, analytical balances, and GC/MS systems) are repaired under commercial service

contracts. It is in the best interest of these service companies to ensure that the instrument is kept in good working order, so most major preventive maintenance is performed by their service technicians.

Examples of routine preventive maintenance for each category of instrumentation are listed in Table 12-1, including frequency of the tasks and lists of spare parts that are kept on hand for maintenance and repair.

12.3 Documentation

Maintenance log books are kept for major pieces of equipment in the laboratory. Non-routine maintenance is documented in these logs for future reference. Routine maintenance may also be documented in the log book, but in most cases separate forms are kept near the instrument to keep track of scheduled maintenance. The minimum entry includes the date, task performed, and the initials of the person who performed the task. If an inspection leads to some further action, that is also included in the entry. In the case of non-routine maintenance, troubleshooting, and repairs, the entry must include the problem, action, and resolution. Service records are kept for all repairs and maintenance performed by outside technicians.

Section 13 Assessment of Precision and Accuracy

Assessment of precision and accuracy as described in this section covers several levels of data analysis. Beginning with bench data approval, the assessment moves on through use of the daily Early Warning Report. Supplementary assessments include use of control charts, project summaries, electronic data review, and annual recalculation of limits. Other sections of this manual cover related subjects, including Section 4 on QA measurement objectives, Section 9 on data reduction, and Section 10 on internal quality control checks.

13.1 Bench Data Approval

13.1.1. Precision

Precision is assessed at the bench on the results of a pair of spiked samples or, where spikes are not feasible, duplicate samples. For assessment, the analyst calculates the relative percent difference (RPD) according to the formula in Section 10.1.4. The result of that calculation must be compared to method-specific control limits (found in the QC Limits section of the BCA Quality Program Handbook).

If the comparison reveals precision outside the acceptance windows, the analyst must undertake corrective action as described in Section 14 of this manual.

In some instances, insufficient sample is provided for use as duplicates or matrix spike duplicates. To provide a precision assessment for such batches, the analyst prepares two laboratory control standards (LCSs). The RPD is calculated just as for matrix spikes; it is compared with limits calculated from analysis of relatively uncontaminated water samples (e.g., groundwaters). While not as valuable as precision data on the actual samples, the LCS precision still provides the key indicator: Was the process sufficiently stable to yield repetitive results on identical samples?

13.1.2. Accuracy

Accuracy is assessed on a matrix basis and on a method basis. For matrix accuracy, the percent recovery (P) for each spiked sample is calculated according to the formula in Section 10. The recovery is compared with matrix-specific control limits from the QC Limits section of the BCA Quality Program Handbook. Results outside control limits are subject to corrective action as described in Section 14.

Method accuracy is assessed separately from matrix accuracy. Whereas matrix accuracy is measured to verify long-term capability of the process for analyzing the matrix of interest, method accuracy assesses the short-term "in control" status of the analytical process. LCSs provide this assessment. Percent recovery (P) is calculated according to the formula in Section 10.1.3 and compared with archived method limits from the QC Limits

section of the BCA Quality Program Handbook. Results outside of control limits indicate a problem with the process and dictate corrective action (as described in Section 14 of this manual).

13.2 Daily Early Warning Report (EWR)

The EWR assists the second party data reviewer in assessing precision and accuracy; its use is specified in Section 15.1 and SOP #QA00989. The analyst will have already reviewed the batch and provided any required documentation of corrective action. In a condensed format, the EWR presents the data reviewer with the entire batch summary, including identification of any outliers and, for those, the limits that were violated. Thus, the data reviewer can verify not only the correct calculation and transcription of results but also the correct application of precision and accuracy assessment.

13.3 Control Charts

The LIMS includes programs for calculating and printing control charts of LCS percent recovery under user-specified conditions. Minimum entries to produce a chart are the analytical determination code and the method, both of which are cross-referenced with analytical results in LIMS. Optional data fields to produce a specific set of control charts include:

- A particular individual determination (ie, benzene) within a multi-component determination code (e.g., 8020).

- A particular instrument ID number, in case a suspected problem is instrument-specific.

- A particular concentration. For instance, if an analysis covers a wide range of environmental samples, two different LCS levels may be in use (for application with high-range and low-range analytical results).

- A choice of including or excluding work analyzed but not yet approved. This permits either retrospective charting or current charting.

Charts may be printed in hardcopy form or displayed directly when a graphics-capable terminal is employed. Warning and control limits are printed on the chart, along with the individual LCS percent recoveries. Such a chart allows assessment of both precision and accuracy over an extended period. Points within limits indicate that method accuracy has met requirements on a batch-to-batch basis. The overall display of the chart provides visual representation of long-term precision. That is, a chart with smooth or gradually shifting responses indicates better precision (over time) than one which jumps from high to low recoveries and back again, even if all points are within instantaneous control limits.

13.4 Project Summaries

Specific data quality objectives may require whole-project assessment of precision and accuracy. To meet that need, a project-based variation of the Level II QC report is available from LIMS. A project manager can specify the combination of any number of laboratory orders (sets of samples) and have the QC data assembled in a combined

format. If the samples are selected by project number, the resulting report is a QC overview of all the blanks, LCSs, duplicates, and matrix spike duplicates in the project. Precision and accuracy can be assessed as individual data items or reviewed as a whole.

If statistical analysis on project QC results is required to meet DQOs, a different computer program is available. Specified laboratory orders are combined into a temporary "QC Detail" file, where calculations are performed on sets of LCSs, duplicates, or matrix spike duplicates to provide such attributes as the mean recovery and the standard deviation. Depending on project requirements, the entire listing or the summary values can be provided.

13.5 Electronic Data Transfer (EDT) Review

An increasing amount of laboratory data is delivered in electronic form, either on diskette or by modem. As an integral part of the EDT process, data to be transferred are first reviewed by the project manager or client services representative. Because the specific fields for transfer may be different from those included in a standard analytical report, a full printout is made of the candidate transfer files.

The reviewer has available the results from samples, blanks, LCSs, duplicates, and matrix spike duplicates. Precision and accuracy are assessed on those QC items as described above. In addition, surrogate results and spiking levels are printed for those tests which use surrogates. Calculating the percent recovery of each surrogate in each sample, the reviewer is able to assess accuracy on a sample-by-sample basis.

When the EDT assessment is complete, the file is approved for transfer. Only at that point is a diskette released for shipment or a telephone call placed for modem transfer.

13.6 Annual Recalculations

Control limits for precision and accuracy are recalculated on a yearly basis. The formulas used for those calculations are presented in Section 4 of this manual.

The process used to develop the annual figures provides another opportunity for assessment. The recalculation uses the same QC Detail file described above for use with project data. For this purpose, the selected QC attribute is assembled without regard to project or client, but based on analytical method and time period of interest.

LIMS assembles data records meeting the selection criteria chosen by the QA coordinator. The data are printed as a list for review prior to final calculation of limits. The QA coordinator can manually edit the QC Detail file to remove obvious outliers and prevent their distorting the limit evaluation. After doing so, the coordinator specifies the calculations to be performed, and summary results are produced.

The mean and relative standard deviation of LCS recoveries are compared to the method accuracy and precision objectives listed in Table 4-1. Method corrective action is initiated if these objectives are not met.

For newly initiated analyses, the historic precision and accuracy limits are compared with those in the method. If at least as restrictive as method limits, the new limits are employed. For ongoing tests that are being recalculated, the new limits are compared with both the method limits and previously calculated historic limits. If a significant shift is revealed, method corrective action is required.

When acceptable control limits have been achieved and the calculation completed, the QA coordinator prints limit lists for use by the analysts. The new lists are issued to

analytical department members and are kept in the QC Limits section of each analyst's Quality Program Handbook. If an analyst changes assignments, the supervisor requests the needed control limit lists from the QA coordinator.

At the time hardcopy updates of limits are issued, the QA coordinator enters the values into the limits archive on the LIMS. As a result, automated reviews such as the Early Warning Report employ the same limits as the analysts at the bench.

Section 14 Corrective Action

Corrective action is taken as required in response to out-of-control situations. Failures occur in two categories: quality control failures, which are random or isolated events, and systematic failures, which require changes in procedure or extensive investigation to determine the cause of the failure. Corrective action is also taken in response to suggestions for continuous improvement opportunities.

14.1 Quality Control Outliers

When specific QC parameters are outside control limits, specific actions must be taken. Guidelines for corrective actions in response to batch QC failures are presented below. Control limits are listed in the QC Limits section of the BCA Quality Program Handbook. Corrective actions for other types of QC failures are included in the analytical SOPs.

Quality control outliers must be documented in the lab notebook or raw data and communicated to the final report reviewer by means of a "Batch Corrective Action Note" (Figure 14-1). Documentation includes, at a minimum, the date, analyst initials, batch number, condition requiring corrective action, and action taken. This information is relayed to the client in a report footnote, cover letter, or case narrative, as appropriate.

14.1.1 Method blank

When any analyte is detected above the RDL in the method blank, the analyte level in each of the batch samples is inspected. If the sample analyte level is less than the RDL or greater than ten times the method blank level, the sample result is reported. Any samples between the RDL and ten times the method blank level are re-prepped and re-analyzed in a new batch, if possible. This procedure is shown as a flow chart in Figure 14-2, "Method Blank Decision Tree."

14.1.2 Matrix Spikes and Laboratory Control Standards

Corrective actions for matrix spike and laboratory control standard (LCS) failures depend on the relationships between the percent recoveries and relative percent difference (RPD) as described in Section 9.2.1. Level I completeness is evaluated to determine if the individual QC parameters are in control. Level II completeness is evaluated to determine if batch corrective action is required. Because the LCS is the principal measure of accuracy and the RPD is the principal measure of precision within a batch, failure of these parameters leads to re-prep and re-analysis of the batch whenever possible.

***B C ANALYTICAL
BATCH CORRECTIVE ACTION NOTE***

Route completed document to Sample Receiving/Report Approval

1. Description:

Orders affected:

Analyst _____

Sample Numbers _____

Client Codes _____

Determination _____

Date _____ Batch _____

Supervisor/Reviewer _____

2. Condition Requiring Corrective Action:

3. Action Requested/Recommended:

Requested by _____

Date _____

4. Action taken:

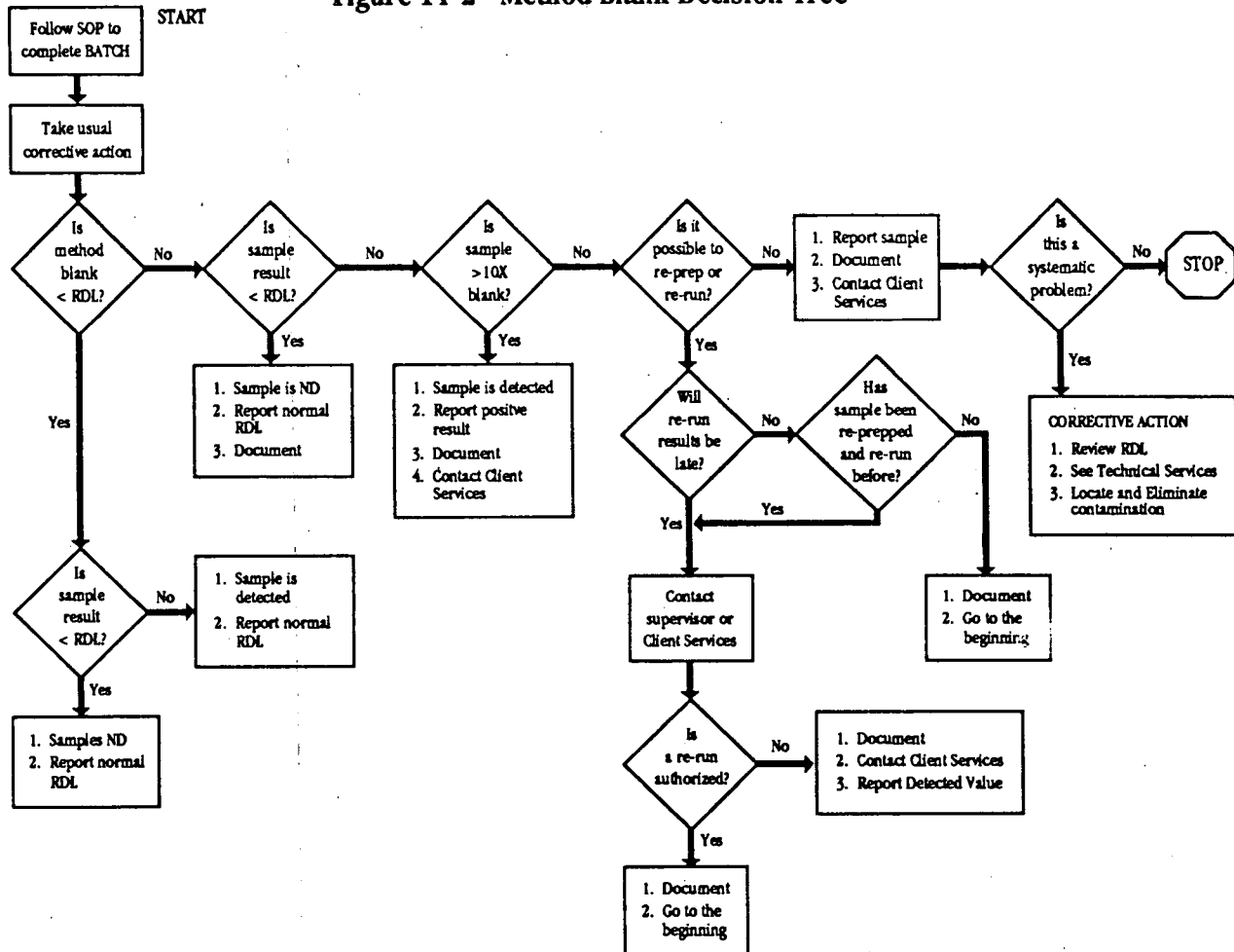
Action taken by _____ Date _____

Action confirmed by _____ Date _____

5. Footnote for Analytical Report/Batch QC Report:

Note goes with (circle): LCS, MB, SPK, DUP, DSPK, SPL: _____

Figure 14-2 Method Blank Decision Tree



14.2 Systematic Process Defect

Systematic process defects become evident when any of the following occurs: QC data consistently out of control; an audit reveals deficiencies; method criteria out of compliance; consecutive failures with performance evaluation samples; and any observation that a laboratory practice does not adhere to requirements. Any laboratory employee may respond to such deficiencies by filling out the first two or three sections of the "Major Corrective Action" form (Figure 14-3). This form is passed on to the department supervisor and the quality assurance coordinator, who tracks the corrective action through to completion. Major corrective action documentation is described further in SOP #QA00789.

14.3 Continuous Improvement Opportunities

When employees are able to identify barriers to total quality, they submit an improvement opportunity to the Process Management Team (PMT). This process is called the Search for Opportunities (SFO). The PMT assesses the opportunity in terms of potential benefits to meeting client requirements for data quality and, if a potential improvement, initiates corrective action. The corrective action process involves assigning an owner to the improvement project, forming a problem-solving team (if necessary), measuring baseline data, and monitoring progress.

Figure 14-3 B C ANALYTICAL MAJOR CORRECTIVE ACTION FORM

***B C ANALYTICAL
MAJOR CORRECTIVE ACTION FORM***

QAC _____

SECTION 1

Originator _____

Date _____

Supervisor _____

Date _____

SECTION 2 Description of Problem (Originator):

SECTION 3 Cause of problem (Supervisor or Originator):

SECTION 4 Outline of corrective action (include responsible parties and dates of implementation) (Supervisor):

SECTION 5

Reviewed by _____

Date _____

Followup dates _____

SECTION 6 Description of followup:

Copies to: Lab Director, QA Director

Section 15 Quality Assurance Reports

Numerical results of quality control tests—QC reports—are delivered as part of the analytical report package. Those reports are described in Section 9 of this manual. Reports that explain corrective action are discussed in Section 14. To monitor the progress of the quality program itself, several additional reports are used.

15.1 Early Warning Report

Each day department supervisors receive "Early Warning Reports" (or EWRs) of all quality control parameters that are outside warning and/or acceptance limits. Such reports allow for prompt corrective action at the bench and, when appropriate, for immediately informing the client. The QA coordinator receives a copy of each Early Warning Report so confirmation of corrective action can proceed in a timely fashion.

Like many other QC practices at BCA, the EWR is batch-based; it is sorted by analytical determination and by batch number. A header section identifies the QC samples and the client (reportable) samples contained in the batch of interest. The remainder of the batch information focuses on two fundamental classes of QC concerns: 1) Batch Errors, which address the makeup of the batch itself; that is, the appropriate number of samples and the number and type of QC support samples must match the pattern designated for the particular determination; and 2) Outliers, which are any QC samples that fall outside of warning or control limits. In the EWR, therefore, both the QC completeness and the compliance with control limits are immediately available to the data reviewer.

15.2 Quality Accomplishments Report

Every month, each QA coordinator files a report of quality accomplishments. Typical topics include continuous improvement activities, results of performance evaluation samples, audits, and client interactions. Without modifying those primary reports, the QA director adds a cover note describing additional labwide QA/QC developments. The combined report is available to all BCA staff.

15.3 Ad-hoc Inquiries and Reports

The BCA LIMS is built upon a relational database that includes a near-English query language called InfoAccess. If some condition in the laboratory suggests a need to review a particular class of data, the information is readily retrievable. For example, if a possible contamination appeared in a trace metals analysis, the QA coordinator can ask to see all sample results for the last six months that fell between the detection limit and the sus-

pected contaminant level. An InfoAccess inquiry can provide the data, sorted in any desired manner. Supervisors, managers, and client services representatives also make such ad-hoc data queries.

Most ad-hoc reports take the form of simple sorted lists. Graphics programs are available on line, allowing pie charts, bar charts, or line graphs to be prepared when it will improve usefulness of the recovered information.